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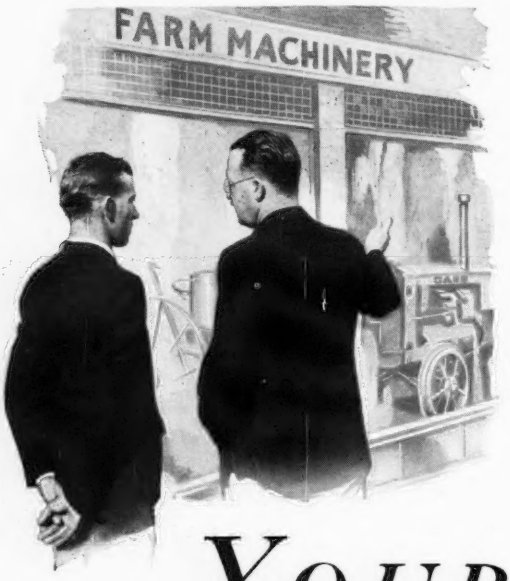

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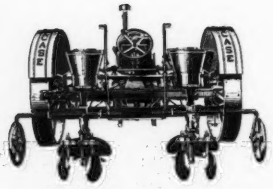

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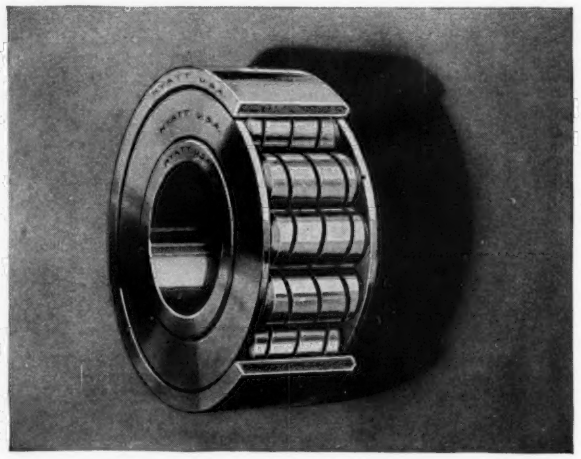

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AGRICULTURAL ENGINEERING

Vol. 11 NOVEMBER, 1930 No. 11

Developing the Electrically Heated Hotbed[1]

By Maurice W. Nixon[2]

IN THE past few years the development of electrically heated hotbeds has come to command attention as a field of prime importance. The use of electric heat in hotbeds promises to develop into a desirable load of large volume and excellent characteristics for the power companies; a new and large market for control and heating apparatus for the electrical equipment manufacturers; and at the same time provide a useful device for the market gardener and home gardener in which to start and force early vegetables.

It is not the electricity itself, as currents which are used in the hotbeds, but the heat developed by the passage of electric energy through a suitably designed resistance. Electric hotbeds, therefore, are not to be confused with various so-called "electroculture" operations.

The original idea seems to have come from Norway, where one Jacobsen observed that the ground surrounding heavily loaded underground cables was so warmed that it enhanced crop growth nearby. In 1922 Jacobsen undertook to heat the soil in a nursery directly by live wires. The idea immediately spread to Sweden, where the royal board of directors of waterfalls became interested and set about developing electrically heated hotbeds to a point of practical usage.

During 1928 there were a great many hotbeds constructed in Germany, most of them patterned somewhat after Edholm's[3] design. In spite of the well-developed horticultural practices in Holland, there have been a number built there. In fact the largest thus far built (1929), some 170,000 square feet in area, was located there. This was rather an indication of the place electrically heated hotbeds can take in gardening.

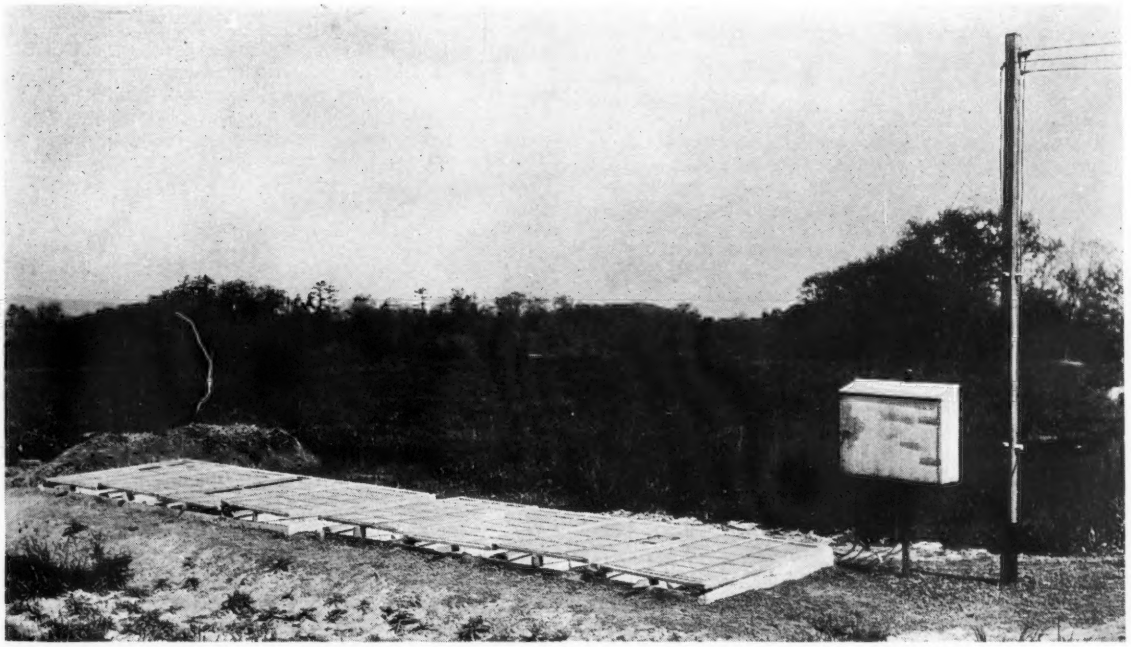
We, in America, have been working on this new type of hotbed for four years. Some eight experimental projects have been outlined and a great deal of information gained as to their operation and usefulness.

The market gardener as a rule has better control over the factors which influence vegetation than the farmer. Through forcing under glass he can partially regulate humidity, light, and temperature conditions. We can all visualize how readily electricity lends itself to the regulation of these factors, not to mention the various advantages as cleanliness, freedom from ammonia fumes,

[1]Paper presented at a meeting of the North Atlantic Section the American Society of Agricultural Engineers, at Rochester, N. Y., October 1930. This paper is based on the progress report on electrically heated hotbeds made to the Empire State Gas and Electric Association by Mr. Nixon, August 1, 1930.

[2]Cornell University.

[3]Edholm, Harald—"The Electric Hotbed for Commercial Garden and the Villa Owner." Royal Board of Directors of Waterfalls, Stockholm, Sweden; Sept. 1927. Swedish work translated into the English.



This is a general view of the electrically heated hotbed test at the New York Agricultural Experiment Station at Cornell University referred to by Mr. Nixon in the accompanying paper

There are a number of factors in the design, construction, and operation which must be worked out by the agricultural engineer before electric hotbeds reach any degree of perfection and can safely be marketed and put in the hands of gardeners. Among these may be mentioned insulation, heaters, sash, ventilation, covers, carbon dioxide supply, and others of minor importance. Many of these studies should be made with the close cooperation with experts in the art and science of vegetable gardening

uniform regulation, ease of operation, and, finally, automatic control.

The electrically heated hotbeds may be constructed and installed so as to be permanent devices, Properly made up they will last a number of years because there will be no strong acids and excess ground water to rot out the woodwork.

Hotbeds should be located on a southern slope, or on the south side of buildings where the ground is warmer; thus located they would be protected from the wind. The site should have good natural drainage. To insure drainage a pit may be dug and filled with gravel or coarse sand. Over this a layer of insulating material should be laid to prevent the escape of heat to the earth. Since the cost of operation would be directly dependent upon the effectiveness of heat insulation this factor would bear careful consideration. Edholm[3] reported a saving of 30 per cent in energy consumption by insulating. The cost of insulating would be of minor importance since it could be used several years, and the advantages are great.

Cinders and charcoal would both make good insulators. Charcoal had the added advantage of liberating carbon dioxide when heated slightly. Charcoal was used in Sweden because it served the two purposes. Charcoal was rather expensive and cinders were relatively cheap, so they were chosen for use in our experiments.

A shallow pit was dug about 2 feet longer and 2 feet wider than the length and width of the hotbeds, and about 2 feet deep. This pit was filled to a depth of one foot with cinders, and the hotbed box built on this foundation. The box was about 18 inches high on the north side and sloped downward to about 12 inches on the south side. For a permanent installation it should be made of 1½-inch tongue and grooved boards well painted. Likewise the board floors and racks should be well painted or otherwise treated for preservation.

The sash should fit tightly against the bedbox and against each other to prevent heat losses. They should be kept well painted, puttied and glazed.

The heating units were mounted in an air space about 4 inches deep. Where open-coil type heating elements were used they were mounted on a board floor. The top of this heater chamber was formed by a six-mesh wire netting screen on which the bed soil was spread. In the sections where strip heaters were used, the top of the heater chamber was formed by a sheet of galvanized iron which tended to diffuse the heat somewhat before it rose to the bed soil. In these sections the screen supporting the bedsoil was mounted 2 inches above the galvanized iron sheet.

About 5 or 6 inches of soil was used in the hotbeds. This solid layer of soil was found to have a more uniform moisture and temperature distribution than flats containing soil. Besides considerable heat escaped between the flats without passing through the soil. For these reasons flats were discarded early in the experiments.

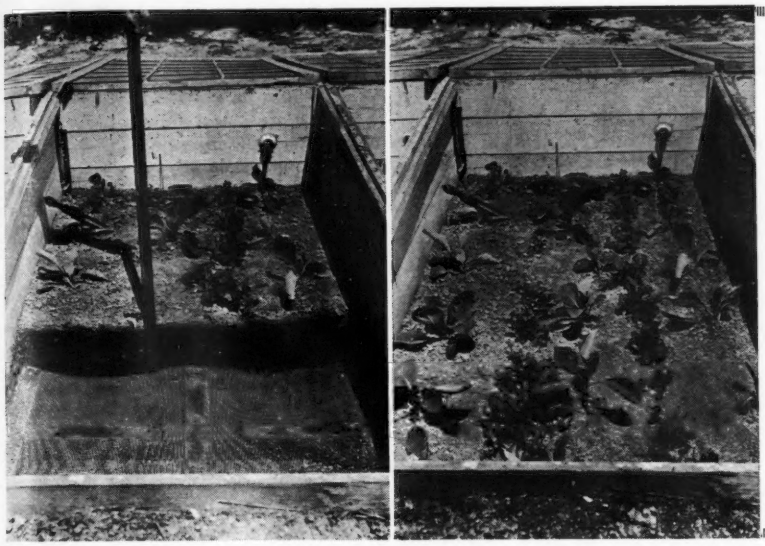
The matter of heating units themselves presented an interesting field. The requirements of the hotbed demanded low temperature, low wattage heaters and ones which might be distributed over a large area.

Various types of cables had been developed in Sweden for direct-contact soil heating. Since nothing of this sort was available in America we used the next best things, which were what we had. Accordingly, strip heaters and open-coil types were installed. The coils were designed to have three heats available, and the strip heaters fed through a rheostat so as to regulate the input to them. Since the source of heat from these units was small, and the temperature consequently high, they were placed in a large air chamber which tended to distribute the heat and temperature. Lead-sheathed heating cables are being designed for direct soil heating, and when available promise to be very good for the purpose. These cables would be laid back and forth across several hotbed sections, spaced at about 6 inches, and would be imbedded in a thin layer of sand which would serve to conduct the heat from the cables rapidly and distribute it uniformly before it passed upward through the soil layer.

Lamps might make a possible source of underheat in hotbeds. However, they have several serious disadvantages. In the first place, the air space in which they would be placed must be much deeper. The excavation therefore would have to be made correspondingly deeper or the box banked higher. Secondly, several lamps would have to be connected in series to secure proper temperature, heat distribution, energy input, and consequent heat flux. If one lamp should burn out, the heat supply would be seriously affected. The danger of burnouts would be much greater with lamps than with other types of heaters.

Except for lamps, the danger of heater burn-out is insignificant. The low operating temperature, sheathing, and stable alloys used, all tend to make the heating unit last indefinitely. Therefore, the units may be installed permanently and left undisturbed for several years. An annual inspection of terminals and connections, however, would be desirable. Considering the long life of the heating units, it seemed unnecessary to supply a door in the side of the box through which the heater and false floor could be withdrawn for repair. Such a device, if used, would interfere with the insulation at the side of the hotbed and would increase construction costs.

Manual control was practical for seasonal regulation of the hotbeds. Automatic control would seem to be satisfactory for daily temperature fluctuations. However, this was not the case, and it was found that the electric hotbed did not lend itself readily to automatic regulation. When a thermostat was placed in the hotbed proper, it was subject to extreme temperature changes which made it impossible to even consider the use of certain types of thermal regulators. Sunlight and shadow cause the air temperature within the hotbed to rise suddenly and drop quickly. This change would not affect the soil temperature directly except at the surface, nor would the



These views give some idea of the construction of the electric hotbeds used in the Cornell experiments and reported in the accompanying paper by Mr. Nixon. Note that cabbage, lettuce and radishes thrived in this hotbed. Five to six inches of mellow soil was used

soil temperature modify the air temperature very much. With such an influence as this affecting a thermal regulator, the heat was turned on and off far from the ideal time of throw, and in disregard of the soil temperature which should have been regulated first.

It was previously mentioned that the hotbed air temperature did not influence the soil temperature appreciably. Indirectly the air temperature had an influence on soil temperatures, in that it affected the rate of radiation from the soil and heat conduction through the soil. The rate of conduction varied as the temperature difference between the soil and air, and the soil temperature varied inversely as the rate of conduction. Thus the soil was affected by outdoor temperature conditions, other than sunlight, but lagged the outdoor conditions by two hours or more, depending upon the violence of the change. A thermal regulator was mounted in the outside air and set to actuate the switches at some certain air temperature; by this means a reasonably uniform temperature was maintained in the hotbed soil. This arrangement had the particular advantage of turning the heat on or off in advance of conditions within the hotbeds.

Although the necessary equipment for automatic regulation would be rather expensive for small installations, it would soon pay for itself in close regulation and by saving electric energy in large hotbed installations operating at one temperature. An additional set of control apparatus would be necessary for each division of an installation intended to be operated at a different temperature.

During a cold period it would not be economical to keep the normal temperature in the hotbeds. It would be sufficient to carry them over without damage to the plants.

The high thermal capacity of the bed soil made it possible to store heat in the ground when it was warm, or only moderately cool, to be used when the ground was colder as during the latter part of the night. Closely allied with this was the possibility of using low-wattage heaters and operating them over a long period of time. By this means heat energy was stored in the ground during the warmer parts of the day and used during cold periods when the supply was not adequate to meet the radiation loss. This action was evidenced by the fact that the soil was gradually warmed when the day was warm and gradually cooled when the day, or usually night, was cold. This characteristic was recognized and employed by the Swedish and German experimenters, as they used off-peak current for hotbed heating.

The necessary heat flux varied somewhat with seasonal conditions, geographical location, and when off-peak current was used, with the total time of operation out of 24 hours. Edholm[3] reported an input flux of 55 to 110 watts per square yard and an average energy consumption of from 1.01 to 1.68 kilowatt-hours per square yard per day. Kind[4] reported an input of 105 watts per square yard and a consumption of 0.84 kilowatt-hours per square yard per day. Kind[4] also reported that 0.042 kilowatt-hours per square yard were required per 24 hours to raise the soil temperature 1.8 degrees (Fahrenheit), with the outside temperature at 32 degrees. A soil temperature of from 68 to 77 degrees which was taken 2 inches below the surface was considered as optimum.

In New York state we have run hotbeds through one winter season to study their operating characteristics under extreme conditions. Three steps of heat flux were available, 37.5, 62.5, and 100 watts per square yard. The following table indicates the energy consumption by monthly periods during the winter and spring season:

1929-1930	Kwh per month per 3-by-6-ft. sash	Kwh per day per 3-by-6-ft. sash	Kwh per day per sq. yd.	
November	79	2.64	1.32	Manual regulation
December	112	3.62	1.81	" "
January	149	4.8	2.40	" "
February	73	2.61	1.30	" "
March				
First 10 days	31 } 58	3.10	1.55	Thermostatic regulation
Second 21 days	27 }	1.28	0.64	Set at 32°F. outside
April				Thermostatic regulation
First 15 days	16.6 } 55.6	1.11	0.55	Set at 32°F. outside
Second 15 days	39.0 }	2.6	1.30	set at 40°F. outside

[4]Kind—"Electrical Soil Heating" from "Die Technik in der Landwirtschaft"; Vol. 10; Bk. 12, 1929. (Siemens Schuckert reprint 409/10) Translated into the English by courtesy of the Westinghouse Electric and Manufacturing Company.

It was observed that in order to keep the hotbeds above certain minimum temperature conditions, a certain heat flux was necessary under certain seasonal conditions. Upon comparing the actual consumption each month with the available monthly consumption, it was noted that each step was sufficient for operation during certain months in the vicinity of Ithaca.

Watts per sash	Available monthly consumption
75	54
125	90
200	144

200 watts per sash was sufficient flux for December and January

125 watts per sash was sufficient flux for November and February

75 watts per sash was sufficient flux for March and April.

It was further observed that to keep the air within the hotbeds above 35 degrees and the soil above 50 degrees, the following flux per 3-by-6-foot sash would be sufficient at the outdoor temperature indicated, recorded between 5:00 and 6:00 a. m.

75 watts per sash at 20 degrees (Fahrenheit)
125 watts per sash at 10 degrees (Fahrenheit)
200 watts per sash at 0 degrees (Fahrenheit)

There was no demand for any more underheat. The three steps available were sufficient, and in fact seemed unnecessary when automatic operation was employed. Two steps would have been satisfactory.

Many hardy plants may be started very early in the season with electrically heated hotbeds. They can be forced until time to harden them off and transplant to the field. The beds may be easily converted into cold frames for hardening off plants merely by turning off the heat. Cabbage plants, seeded on February 24 were ready to transplant in about two weeks. Other plants were as successfully forced.

It was possible also to use the hotbeds during the winter. Radishes were planted October 15; on November 26 they were thinned and a large double handful harvested from four sash. More harvests were made on December 8 and 28, and on January 22. Lettuce planted at the same time kept over winter and was successfully forced during late February and March.

The cost of electric hotbed construction is rather a difficult matter to discuss because they are new and in America we have not yet established any particular design. The Swedish type cost about $4 a sash for large installations. This included sash, lumber, drainage tile, and shutters for covering, which was about the same as for manure hotbeds. The cost of electrifying, including charcoal insulation was about the same, making a total of about $8 a sash. The heating cables and covering shutters could safely be amortized in 5 years and the rest of the outfit in 15 years. The electric hotbed would last much longer than the manure hotbed without rebuilding.

The operating cost of the electric hotbed depended largely upon the price of electric energy. Off-peak energy for hotbed heating ranged from 1/6 to 1½ cents per kilowatt-hour in Sweden. For a two-month period from April 11 to June 11 Edholm[3] ran a manure and an electric hotbed at about the same temperatures and found that a cubic yard of good manure was equal to 88 kilowatt-hours for heating. At this rate, for heating alone one could afford to pay one cent per kilowatt-hour for electric energy for each 90 cents per cubic yard which manure would cost him. He could really pay more considering the saving in replacement, amortization costs, and the many advantages offered by the electric hotbeds.

Kind[4] reported construction costs of manure and electric hotbeds nearly equal, as Edholm, but found a still greater differential in operating costs in favor of electricity for heating.

Electric hotbeds as now used in this country are competing favorably with manure hotbeds in cost of operation, let alone the advantages of automatic uniform temperature control, good drainage, and so forth.

We tried to use straw mats to cover the hotbeds, but they filled with snow and ice, rendering them difficult to manage; therefore they were discarded. The hotbeds ran at a uniform temperature without this protection over the sash. In very cold weather the air temperature ran around 42 degrees and the soil 55 to 60 degrees, making a uniform difference of about 15 degrees. The hotbed temperatures were independent of daily fluctuations in outside conditions due, no doubt, to the insulation around and underneath the hotbeds.

Moisture would condense and freeze on the underside of the sash when the outside temperature fell to about 20 degrees.

The thickness of this frost layer varied inversely as the outdoor temperature and so regulated the heat losses through the sash that remarkably uniform soil and air temperatures were maintained in spite of rather extreme changes in outdoor temperatures.

There was nothing unusual about the operation of electrically heated hotbeds except that there was a chance to have uniformly regulated temperatures. The bedsoil should be prepared as any hotbed or garden soil, and kept in good tilth. Somewhat more water was required than in manure hotbeds because the drainage was excellent and free water percolated through the bed immediately and was carried off, leaving only the capillary and hygroscopic water in the soil which was an ideal condition for plant growth.

No more attention was required than was necessary for manure hotbeds; in fact, much less was necessary when automatic control was used. Ventilation should be done judiciously to conserve heat during cold weather; very little was required for air changing and moisture regulation. During warm bright days the sash could be raised 5 or 6 inches on the leeward end, usually south, to cool the air because direct sunlight would make the beds very warm. A certain fixed air temperature could not be maintained on account of daily temperature variation and sunlight. However, the soil could be kept within a very narrow range.

Government weather bureau reports were desirable to follow because they gave an indication of the approach of warmer or colder weather and the heater capacity was regulated accordingly, often before the new condition was felt within the hotbed. The twofold advantage of this was the saving of current upon the approach of warmer weather, and storing more heat in the hotbed upon the approach of cold weather.

There are a number of factors in the design, construction, and operation which must be worked out by the agricultural engineer before electric hotbeds reach any degree of perfection and can safely be marketed and put in the hands of gardeners. Among these may be mentioned insulation, heaters, sash, ventilation, covers, carbon dioxide supply, and others of minor importance. Many of these studies should be made with the close cooperation with experts in the art and science of vegetable gardening.

The time factor is of great importance to the market gardener; a few days difference in the time of maturity and marketing of a truck crop often means a vast difference in the value of the product. Many crops cannot be set out in the field until the frost hazard is past. It is a standard practice to germinate and force early growth in hotbeds; harden the young plants and set them out when the weather permits. The agricultural engineer can play an important part in the development of this device to speed up and facilitate this early forcing period.

Adapting Machinery to Corn Borer Control[1]

By R. B. Gray[2]

THE most effective and practical means of controlling the European corn borer yet found lies in the adaptation and use of farm machinery. As no generally effective method has been found of combatting the corn borer in the growing corn crop, control measures must therefore be applied either during or after harvest.

In general there are two requirements to be met which are dependent on the manner of harvesting: (1) Disposal of the standing stalks left in the field after machine or hand picking, and (2) the complete removal of the whole crop from the field, together with the effective control treatment of the resulting fodder.

Extensive field experiments and surveys conducted in the western infestation by the U. S. D. A. Bureau of Entomology brought out the fact that although better than 50 per cent of the borer population contained in plowed-under cornstalks migrate to the surface of the soil, 100 per cent of these in the absence of shelter in a cleanly plowed field, perish as a result of undue exposure to the elements, or fall victim to birds, predacious insects, rodents, and other predators before pupation and emergence.

It was also shown that overwintering borers returning to the surface in plowed fields will not enter green plants growing in the field, green corn following corn in the same field, or green plants at the margin of the field.

It should be pointed out that ideal clean plowing consists in completely covering the stalks and debris so thoroughly that no pieces are visible between the furrow creases and that no piece of stalk large enough to harbor a borer remains on the surface. Borers could find refuge in a stalk no bigger than a lead pencil.

Under ordinary soil and field conditions the use of medium width and wide bottom plows in good adjustment, fitted with standard corn borer control equipment such as coulters, jointers, and trash wires, and carefully operated, will produce very good coverage. Where rocks and stones abound or where the soil is particularly heavy, it may be necessary to remove some or all of the stalks to effect the necessary clean plowing.

Many tests have indicated amongst other things that the physical condition of the soil materially affects a plow's ability to cover; soils in poor physical condition—devoid of humus—not crumbling easily as the furrow slice is turned and consequently not covering well.

[1]Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers, at Rochester, N. Y., October 1930.

[2]Senior agricultural engineer, U. S. Department of Agriculture. Mem. A.S.A.E.

Raking corn stalks with a special four-bar, flexible-tooth side rake used in corn borer control experimental work

Another factor of importance in good coverage is the width of open furrow left by a plow, the widest open furrow having the greatest capacity to hold turned-under stalks.

It has of course also been found repeatedly that the difficult stalks to cover are those within a few inches of the landwheel side of the furrow slice because of the small amount of dirt left with which to cover, compared with the quantity with which to cover when the stalks are rooted to the furrowwheel side.

In order to meet the difficult condition of stalks on the landwheel side, particularly in heavy soils, an experimental so-called floating-scraping trash shield has been devised. Preliminary tests with this attachment give promise of excellent results.

After a clean job of plowing has been done, its effectiveness as a control measure depends on keeping the stalks buried. Consequently care in the selection and use of subsequent tillage and seeding tools is of great importance so that no stalks may be brought again to the surface to afford shelter for migrating borers.

In the western area very little difference as a control measure is apparent regardless of whether the stalks are cleanly plowed under in the spring or the fall. The important factor is that the stalks remain buried until after pupation and moth emergence. In eastern New England where two generations of borers occur each year, however, it has been found that plowing late in the fall produces the best control. This the entomologists tell us is probably due to the lack of time for hardening, of the second brood, to resist the rigors of winter, particularly when they are underground and out of their natural surroundings. In this area not only must all corn crop remnants be cleanly plowed under, but likewise all other infested pithy-stemmed plants known to be hosts of the corn borer.

When the stalks are not to be plowed under, completely detaching the stalks flush with the ground surface, raking cleanly into windrows and carefully burning all stalks and bits of trash thus raked, constitutes another control combination.

In order to do a good job of raking each and every stalk must be detached. Poling or railing (dragging a pole or railroad rail crosswise of the rows down the field), even if performed under ideal conditions—no snow, high moisture content of stalks and temperatures around zero—has shown from repeated tests that many stalks remain undetached. It might be noted that in the Toledo area ideal conditions for poling were not approached more than two or three days during each of the past three winters. This started the development of stalk shavers which have now been so devised as to shear practically all of the stalks off at the ground surface. The first type developed, the sled stalk shaver, consists of a sled with 2-by-4-inch runners shod with strap irons and fitted on either side with a serrated lister cultivator blade projecting outward toward the rear. This will cut two rows. Attached to the back end is a disk coulter for the purpose of preventing the sled from weaving sidewise as the stalks are cut. To cut four rows at one time two shavers abreast may be used and pulled with either horses or a light tractor. A wheel-type shaver also available has a steel framework supported on two wheels and fitted similarly with two blades. The sled-type shaver may be made by the farmer himself and the wheel type may be purchased from the manufacturers. Developed also is a three-row shaver attachment for a single-row corn cultivator. While this has been worked out for only

(Left) A three-row cultivator sled shaver with blades lifted, used in corn borer control. (Right) A good example of clean plowing in heavy soil for corn borer control, using a two-bottom plow with coulters, jointers and wires

one make of cultivator, it is proposed to adapt the attachment to other makes and then perhaps be made available by the manufacturers. A four-row attachment for a two-row cultivator is also under consideration as are also attachments for tractor cultivators.

After the stalks are detached clean raking into piles or windrows follows. The closely spaced heavy-tooth cornstalk rake may be used to rake up most of the stalks and then followed by the ordinary side rake for finishing, or by using a special four-bar side-delivery rake, the clean raking can be done in one operation. This is the ordinary three-bar side rake reconstructed to take four bars fitted with double the original number of teeth which are specially designed for flexibility. A shield is placed over the top of the rake to prevent stalks being pitched through and a shield is fitted to the rear as a protection against winds. This machine will rake hay equally well.

Burning of the stalks is then carried on by igniting the windrows or piles and using care that all bits of stalks and plant debris are consumed by the flames. In the two-generation area all pithy-stemmed weeds should likewise be consumed by the flames.

The thought has often occurred as to whether the stalks could not be so mutilated as to be left on the field and permit the sowing of small grain with safety. Experimental machines have been designed and tried out and others are now being considered in the hopes that soon this most difficult of machinery corn borer control problems will be solved.

Because of the increasing use of the corn picker in the larger corn raising areas, opportunity is offered to mutilate the stalks as the corn is being picked, thereby having a once-over machine. Attachments such as crushing rolls, shredder heads, etc., are being studied with this end in view.

The second requirement, removing the whole crop from the field, may be accomplished with the binder fitted with the stationary-knife low-cutting attachment, which cuts the corn at or below the ground surface. This device consisting of a long curved blade, attached in a horizontal position to a combination shoe and weed guard, elevating chute, special throat springs and gathering chains may be made up by the farmer himself or purchased at a nominal cost for any of the four binders from the respective manufacturers.

For conditions where the use of binders is impracticable or impossible the low-cutting hand hoe was developed. This permits cutting corn at the ground surface in small fields, on side hills, and in extremely stony fields.

As the standard binder leaves stubble at least 5 inches high, and as the regular corn knife may leave stubble practically any height, it can readily be seen what a menace the borers left in the stubble would be, particularly in heavily infested fields. The following table supplied by the entomologists gives the percentage of the whole number of borers, originally in the whole stalks, found in the remaining stubble; these data were taken in a heavily infested field in the western area in early October, 1927:

Percentage of Borers Left in Stubble

Average height stubble, inches	Average per cent of total number in stalk left in stubble
0 (ground surface)	0.6
2	1.0
4	5.5
6	10.0
8	16.5
10	21.0
12	25.5
14	34.0

A stationary-knife low-cutting attachment similar to the one for the binders has been developed for the ensilage harvester. In one operation, therefore, the stalks may be cut off flush with the ground surface, elevated into a cutter head, and chopped into ½-inch lengths, thereby producing a high borer mortality. As this chopped fodder is ordinarily put into the silo, any surviving borers, as shown by tests, will succumb to the fermentation action of the juices therein.

When the stalks cut by the low-cutting binder are put through an ensilage cutter similar fate awaits the borer and a high measure of control is effected.

If the low-cut stalks are to be put through a husker-shredder, a high mortality likewise results if care is exercised in the operation. The stalks should be fed evenly, cutter head run at normal speed, and high pressure maintained on the snapping rolls. Any debris around the machine should be cleaned up when the job is finished and any shelled corn destroyed. It has been found that many live borers rolled up to about the size of a kernel of corn are shaken out of the shredded fodder with the shelled corn and unless they are destroyed are a menace. Tests have shown that an 83 per cent mortality may be effected in the snapping rolls alone, and an average of 94 per cent when the fodder passes entirely through the machine. Of the 6 per cent of the borers surviving 5 per cent were shaken out of the shredded fodder and deposited in the shelled corn and in the debris under

the machine. As these latter can easily be disposed of a total borer destruction of 99 per cent is possible.

A number of other machines and attachments are in the experimental stage and give varying degrees of promise. Included in these are field burners, garden patch burner, field stalk chopper, down-stalk lifting finger attachment for binders, pickers, and ensilage harvesters, and various plow attachments, stalk loader, etc. The efficiency of a corn binder or ensilage harvester depends on the per cent of all the stalks in the field which can be bound or chopped. The efficiency in corn borer control is likewise affected. The purpose of the lifting fingers, therefore, is not only to increase the efficiency of the machine as a harvester but also as a more effective corn borer control weapon by lifting badly down stalks which otherwise would be missed.

In closing it would seem appropriate to take this opportunity to give an expression of appreciation for the wonderful spirit of cooperation manifested by many of the farm machinery manufacturers in this work and to add the hope that still further cooperation may be had. The pest is such a potential menace that the ingenuity of all is going to be required if it is to be satisfactorily controlled. Some of the experiment stations have cooperated wonderfully; others have done fine work on projects of their own. There is, however, need for much more work on this problem and I hope that soon all the experiment stations of states in or near the infested area will start an agricultural engineering research program looking to the development of better methods of controlling the corn borer in their states so as to be able to hold down the ravages of the pest when the need arises.

Clearing Tight Stones from Farm Lands[1]

By R. U. Blasingame[2], N. A. Kessler[3] and H. B. Josephson[4]

STUDIES of the cost of plowing in stony ground[5] have shown that the operating cost of modern power machinery under these conditions may be as great or greater than the cost of operation of horse-drawn machinery. In other words, the stones in the fields of many farmers in Pennsylvania and other states represent an obstacle to be overcome before modern power field machinery can be used to lower costs of production on these fields. It has also been shown that labor is the largest item of cost in clearing fields of stones[6]. In view of these facts a cooperative project was organized this year by the department of agricultural engineering, Pennsylvania Agricultural Experiment Station; division of agricultural engineering, U. S. Department of Agriculture, and the Atlas Powder Company, to determine whether or not the cost of land clearing could be materially reduced by the use of improved methods. The work was done in the spring.

METHOD OF PROCEDURE

A field on the Pennsylvania State College farm was cleared of all rock coming within plow depth. The field was plowed somewhat deeper than is usually practiced (about 9 inches), using a standard two-plow tractor outfit. A record of the time required was kept. As the plowing was done stakes were placed to mark the location of each rock encountered by the plow. This was done by an assistant so as not to interfere with the plowing time.

A survey was made of the field and a topographical map prepared showing location of all rocks. This map had one-foot contour lines. Permanent bench marks were established from which observations may later be made to determine whether soil erosion has occurred which might account for other stones appearing at plow depth. Rocks that were not too large were pulled out with a heavy subsoiler drawn by a tractor. Blasting was done when necessary. The broken pieces were pulled out with the subsoiler and tractor after which the stones were hauled off the field on stone boats and wagons.

The records include (1) man labor in hours for different operations, (2) number of hours the tractor was used, (3) fuel and oil used in tractor, (4) quantity and cost of explosives used. Observations were made on the effectiveness of the machinery used for pulling out rocks and removing rocks from field.

Two fields, one of 8 acres and one of 100 acres, were included in this project. The work on the 8-acre field was completed and will be used as a basis for the discussion of the preliminary results thus far obtained.

OBSERVATIONS

This field was rectangular in shape and somewhat higher on the east side than on the west. The east side was thickly covered with limestone varying from solid ledges to scattered stones of varying sizes. There were few stones on the west side. The ledges were masses of layered rock which in some cases had been partially washed out between layers and filled with a layer of soil varying in thickness from a fraction of an inch to an inch or more. The solidity of the rock was also somewhat broken in vertical planes and the cracks filled with soil. Rock layers were not uniform in thickness but varied from a few inches to eight or ten inches. Soil covered the rock to depths varying from a few inches to a foot or more, often in a short distance. Scattered stones ranged up to large flat rocks six or eight feet long and five or six feet wide.

First attempts to root up the stones with a subsoiler pulled by a tractor were not successful. Large flat stones would come free of the soil only to jam between the point of the subsoiler and the wheels, throwing an excessive strain on the machine. Then, too, a pull with a rock in this position caused the stone to plow into the ground and stall the tractor.

After further trials it was decided that a change in technique in handling the machine might help matters. Instead of hitting the rocks squarely in the center, we tried to hit them well to one side. This method proved much more effective since the rock could hit only one wheel. In pulling it turned on edge or, if too large, would be pulled from its bed in a horizontal twisting motion which put practically no strain on the wheels. The load fell on the parts which were designed for heavy strains.

In proceeding with the work proper, the machine was set at a depth of about ten inches and was drawn across the stony parts of the field by means of a track-type tractor. Whenever a stone too large to be moved was encountered, it was marked by a stake. Other large stones when struck near the center were left until the return trip across the field. Smaller stones offered no particular resistance and in most cases were turned up so as to be easily seen for loading.

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[1]Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers, at Rochester, N. Y., October, 1930.

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[3]Associate land clearing specialist, division of agricultural engineering, U. S. Department of Agriculture. Mem. A.S.A.E.

[4]Associate professor of agricultural engineering, Pennsylvaia State College. Mem. A.S.A.E.

[5]"Tractor Plowing in Stony Ground," by H. B. Josephson, AGRICULTURAL ENGINEERING, Vol. 9, No. 8 (August, 1928).

[6]"Cost Studies in Clearing Limestone Land," by H. B. Josephson, AGRICULTURAL ENGINEERING, Vol. 9, No. 9 (September, 1928).

Subsoiler rooting up a fair sized limestone which was within plow depth of the surface. This picture illustrates the technique of hitting the rock well to one side of the center. As many fields need more than 15 cubic yards of stone removed per acre and this method saves 42 cents per yard over the best method previously tried, the saving is important

After the field has been subsoiled, explosives were used to break rocks too large to handle. Those rocks which had been twisted free from their original locations were mudcapped and the immovable stones were snakeholed. In the latter case the stones were sufficiently broken so that the subsoiler would turn them out of the ground without any great difficulty. Mudcapping was in most cases simplified because in twisting the rocks out of the ground the soil on top had not been materially disturbed and in preparing for the mudcap it was only necessary to dig the soil away from the rock in one spot.

When the visible stones were hauled away, the subsoiler was again drawn over the field to turn up rocks missed the first time, and to loosen or turn up those which had been snakeholed.

As the rock was very brittle the velocity of 40 per cent dynamite seemed to be excessive. A low-density powder, running about four sticks to the pound, was tried. With a few exceptions one-half stick of this type of explosive was sufficient to break the rocks turned out by the subsoiler. The slower velocity seemed to be more effective in getting good breakage. In snakeholing the larger rocks not moved by the subsoiler one or two sticks per hole were usually sufficient to cause good breakage. Table I shows the cost figures obtained, and Table II shows how the total costs compare with those of methods previously reported.

In view of the fact that the smaller farmer might not have sufficient funds or a cleared area sufficient to warrant owning a tractor and subsoiler, it was considered advisable to design a small hook which could be used in combination with a team or light type of tractor. A hook made from a plow beam and equipped with plow handles was first made and tried. This did not prove very effective. A hook was made by bolting two bent steel plow beams together so that there was a space of about eight inches between the two where the downward bends occurred. The original bends of the beams were modified so that the pull of the team or tractor would give the hook suction. This hook was tried out in combination with the subsoiling machine with the idea that any rocks not completely exposed by the subsoiler could be pulled to the surface by means of the hook without loss of time. It is possible that more experiments in connection with the homemade hook will indicate possible improvements. The plow beams used in making the homemade hook had been bent in plowing stony fields on the farm, and are an indication of the extent of machinery damage as a result of working these stony soils.

In connection with hauling, the work clearly indicated that for fairly long distances the wagon was far superior to the stone boat. While the stone boat had the advantage of ease in loading, not only of small but also of large rocks, it had the disadvantage of smaller capacity and greater draft. The wagon could only be loaded with stones which could be lifted to the wagon bed by hand, but the loads were much larger and hauled with less exertion on the part of the team. It would be worth while knowing how much could be spent in labor or dynamite to break stones to a size which could be readily hauled on a wagon as compared to the cost of hauling on a stone boat, not breaking the stone in small pieces and using a light tractor for hauling instead of a team.

TABLE I. Cost of Clearing 7.3 Aacres

270 man-hours, at 30 cents	$81.00
164 horse-hours, at 20 cents	32.80
32 tractor-hours, at $1.00	32.00
16 hr. use of subsoiler, at $1.00	16.00
137 sticks dynamite, at 5½ cents	7.50
193 caps, at 2 cents	3.86
200 ft. fuse, at $1.50	3.00
Total	$176.16

TABLE II. Comparison of Clearing Costs

Method	Volume of rock removed per acre, cu. yd.	Cost per acre	Cost per cu. yd.
Drilling and blasting*	31	$53.22	$1.72
Mud capping and snakeholing*	18	35.08	1.95
Hooking loose, mudcapping and snakeholing	18.5	24.00	1.30

*Results previously reported[6].

Present Status of Research in Farm Electrification[1]

By Geo. W. Kable[2]

THE use of electricity on the farm has increased at a rate beyond the expectation of most of us. Many farmers who formerly objected to a minimum monthly bill of $1.50 are now cheerfully purchasing $30 to $40 worth of power per month. During the first seven months of this year, 70,000 farms were added to those already enjoying the use of electricity. This was an increase of 13 per cent. This increase in the use of electricity is due in part to the intensive studies and investigations which have been made during the past six years.

Organized research in farm electrification started with the establishment of the Red Wing (Minnesota) project in 1923. Since that time investigational programs have been undertaken in 24 states.

The work of all of these state organizations has been similar. It has involved the making of surveys to learn something of the use, demand, cost and value of electric service on the farm, and the fundamental difficulties involved in an extension of this service. These surveys brought out the fact that in order to have satisfactory farm service there must be a larger number of satisfactory uses for electricity on the farm. The next logical step was to attempt to develop such uses. A great variety of studies and investigations has resulted. It was to be expected that the first problems to be undertaken should be the ones easiest to solve. They involve, for the most part, the substitution of electricity for some other source of power, heat or light in the performance of established operations. These attempted substitutions brought out difficulties in the adjustment of speeds of machines, in the adaptation of high-priced heat to inefficient equipment, and in the inadequacy of much of the equipment not designed for electric operation. The result of taking these problems into the laboratory for study has been the development of better brooders, feed grinders, ensilage cutters, farm motors, refrigerators and other equipment. That these results have been worth while is evidenced by the greatly increased use of electricity on farms and the constantly increasing demand for service in rural territory.

STATUS OF STATE PROJECTS

At the present time ten of the 25 state rural electrification projects are receiving 50 per cent or more of their support from utilities within the state. Out of these ten, two are devoting more than 50 per cent of their efforts to extension programs, while eight are placing the major emphasis on investigations. Seven states have work being carried on actively by the colleges, although not receiving as much as 50 per cent of the support for it from outside sources. Of these seven, four are devoting in excess of half time to extension programs and three are devoting more than half time to research. In four states where there is no outside support, the college is carrying on a small amount of work. These four include some of the states where the original program has been completed. In two states where the demonstration farm program has been completed, there is no activity at the present time. In South Carolina the state organization did not get well under way, while in Oklahoma the state committee is just now being reorganized.

Assuming that New England is represented by the New Hampshire project, three-fifths of the states have been giving attention to farm electrification. The major activity has been in the northeastern states, middle western states and on the Pacific Coast, with Alabama and Texas representing the South.

Where state programs were built originally around a "demonstration line" these programs have in nearly all cases been terminated. Some of these states are now engaged in full-time extension activities while others have chosen a few of the more pertinent subjects needing investigation and included them as regular experiment station activities. The type of work undertaken depended largely upon the inclinations of the persons most actively connected with the project. All of this work, whether experimental or extension, deals with problems of im-

[1]Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers, at Rochester, N. Y., October 1930.

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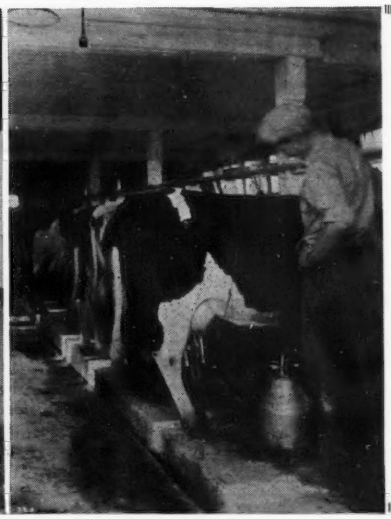


The human problem is one of the most inept considerations in the development of farm electrification; in this respect it is especially a great boon to farm women. In the application of electricity to milk production what is needed now is to combine a number of miscellaneous uses in an attempt to develop a highly efficient milk production plant with low labor cost, quick capital turnover and a high quality product

mediate application to our present needs and present farming methods.

The general tendency throughout the country has been to approach rural electrification as a farmer's problem. The experiment stations and extension services, which have been specially endowed to work on farm problems, are gradually accepting rural electrification as one of the fields in which they have an unusual opportunity to serve. Even from the standpoint of the power company, rural electrification is primarily a farm problem. It is only by the solution of the problem to the satisfaction of the farmer that the power company will be called upon for additional service.

NATIONAL RURAL ELECTRIC PROJECT

In 1928 the National Rural Electric Project was established. Its organization and program were similar to that of other state projects, except that it had a larger budget for making a more careful economic and sociological study of the effect of electricity on farm life. It was also expected, because of its location, to have greater influence in demonstrating farm uses of electricity. The farm demonstrations have been established and a number of investigations of the type being worked on elsewhere are under way. When the author came to the National Project, it was with the understanding that eventually the major function of the project would be research of a type which had not been or could not readily be undertaken elsewhere. A plan for carrying out this program on an enlarged scale was prepared at the request of the Rural Service Committee of the National Electric Light Association in the summer of 1929. One of the chief recommendations of that plan was the making of a survey of research activities throughout the United States, this survey to be the basis for developing a national program of research. The recommended research survey was authorized to be made. Action on the plan itself was postponed pending the completion of the survey.

THE RESEARCH SURVEY

The field work of our research survey has been terminated for the present. It was found that the collection of data could not be completed because each day brings information concerning some new source of data or some new agency at work.

A large number of research agencies throughout the country have been visited. These include the federal department of agriculture and the state agricultural experiment stations as the chief sources of information. It was found that in addition to the work of the rural electrification projects there were many investigations under way in the experiment stations which had a direct or indirect bearing upon the use of electricity on the farm. Departments in universities, not connected with the agricultural experiment stations, are also producing research results which will eventuate in practical applications in agriculture. Semi-public institutions, such as Boyce Thompson Institute and the Smithsonian Institution, have most interesting investigations under way in which electricity plays a prominent part. It was also found that the public utilities companies are conducting a certain type of investigations and development programs which are adding much to the fund of new information on farm electrification.

While we do not have a record of the exact number of men employed, the use of electricity on farms is now receiving the full attention of perhaps one hundred investigators. A thousand more are devoting some time to specific problems. Electricity has become so commonplace in most laboratories that investigators often use it daily without realizing its significance in their results. Many investigators are working on fundamental problems in which electricity may not be involved at present, but which are laying the foundation for a new science of agriculture in which electricity will be a most important factor.

A few examples of the type of investigations under way may be of interest. Refrigeration ranks as the most popular subject being investigated. We have a record of 35 projects on dairy refrigeration and about half that many more on general refrigeration, farm cold storage and frozen fruits. Hay drying and sterilizers for milk utensils rank next with 18 and 16 investigations, respectively. Hotbed studies are also popular with twelve reported. There were 14 investigations on brooding, 10 on feed grinding, 7 on feed mixing, 26 on water heating divided between water heating for the dairy, for the home, the poultry house and the stock tank. Insect control is being approached from various angles, a number of studies being made on the effect of lights and various types of electric traps.

Getting outside of the field of the rural electrification specialist we find a somewhat different type of research activity. Eight projects have been listed, for example, on the effect of static electric charges. One of these studies deals with charges on bacteria. The investigators in this case were able to correctly classify the potency of nitrifying bacteria contained in ten samples of legume nodules by the measurement of the electric charges on the bacteria. A similar investigation is under way with pollen grains. Other studies include the effect of electric charges on the blood of animals, on soil particles, and on plants. This type of investigation is strictly fundamental research, but it offers perhaps as great, if not greater, possibilities for unraveling the mysteries of electricity in soils and plants than do the nine investigations of the electric plow which have been reported.

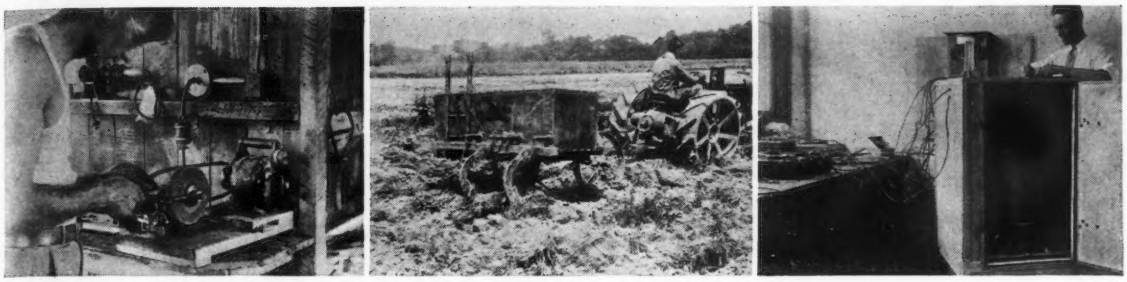
The use of light for other purposes than for illumination is receiving much attention. Sixteen investigations have been reported on plant growth, and five on production of flowers. Others include the ripening and coloring of fruits, the stimulating effect on young chicks and livestock, the prevention and cure of disease and the stimulation of egg production. The use of ultra-violet irradiation is receiving about the same amount of attention as light of other wave lengths and for the same purposes.

X-rays are being tried on plants, animals, seeds and flowers. A new method of soil analysis by the use of the X-ray is also becoming popular.

Various other types of rays and waves are being given an opportunity to prove their value in different laboratories. The effect of Cathode rays on the production of vitamins is one of these. Doctor Headlee, state entomologist of New Jersey, is using radio waves to kill insects. He has found that insects placed in a field of certain wave lengths will generate internal temperatures which cause them to die. Similar effects are being studied in other laboratories for the induction of artificial fevers for the control of human disease. In a private laboratory in Tuxedo Park, New York, some rather elaborate equipment has been set up for use in producing and studying supersonic waves. These waves are produced electrically and have a quite remarkable effect on some substances and forms of life.

Down in Tucson, Arizona, there is an experimental electric house heating installation which is a duplex paradox. In the first place, a refrigeration plant is used to supply the heat, and the second impossibility is that the manufacturer will guarantee an apparent efficiency of 400 per cent. This application of the Carnot heat cycle for cooling and heating buildings is not new, but its practical application is still a matter of research.

A detailed account of all these investigations and many others will be included in the report on this survey. It will be published by the Committee on the Relation of Electricity to Agriculture and will be ready for distri-



(Left) The substitution of electricity for other forms of light, heat and power for performing established operations was the first step in applying electricity to agriculture. (Middle) Here the various types of electric waves and rays are being given an opportunity to demonstrate their worth; the device being used is an electric plow. (Right) This picture shows in process a laboratory test of electrically heated sterilizers for dairy utensils; this development is receiving a great deal of attention

bution this winter. The report will also include requests made by men in the field for investigations of problems which they think important and a general summing up of the adequacy of present studies and the need for further work along particular lines. As one of the steps in the preparation of this report a card index of research projects and suggestions is being prepared. It will be classified by subject and by states and will be maintained and kept up to date as a record of active rural electrification investigations.

POSSIBLE FUTURE DEVELOPMENT

The development of the use of electricity on the farm had to start somewhere. Each piece of equipment made to serve a useful purpose brings the general use of electricity that much nearer. As economic pressure increases, however, the time must come when we will give more thought to the use of electricity in the economical operation of the farm as a whole. The milking machine, the electric clipper, the fly spray gun, the feed grinder and mixer, the silo filler, the refrigerator and milk cooler, the water heater and equipment sterilizer may all be good pieces of equipment individually, but to serve their purpose best they must be properly combined and installed to make a highly efficient 15, 30 or 50-cow milk production plant with a low labor cost, a quick capital turnover and a high quality product. In other words, the ultimate goal of farm electrification is not motors and meters but good sound engineering analysis and management proven by the annual net income. This problem, in my opinion, should occupy first place in future farm electrification studies.

An analysis of agricultural production shows certain outstanding features. The Department of Agriculture states that 60 per cent of the cost of production goes for labor and power. Seventy per cent of the power, and perhaps as much labor, is involved in field operations. We have been content to shoot the quail and rabbits but have been scared, and sure that our guns were too small to tackle the field power bear. Some day a David will come along with a slingshot and give us all a chance to eat.

Electric field power deserves attention. It is one of the big opportunities for electricity on the farm, and it will most surely never be a reality until some one tries it in an American way for American conditions.

Pest and disease control is another of the big farm problems. The damage is enormous. The expenditures for control are equally so. The magnitude of the problem is indicated by its inclusion many times over in every experiment station program. A start is being made with light traps, electrocutors, radio waves and X-rays, but the field is entirely open with no immediate prospects for a complete coverage patent.

Electroculture is another of the "scary" giants. It has been classed by some with water witching and other psychic phenomena. We recall also the "impossibility" of the steam engine and the horseless carriage after many attempts and failures. So long as anyone anywhere gets any apparently favorable result from electric plant stimulation, the attempt is still worth making. There are many things about electricity and about plants which we do not yet know as is evidenced by the things we have recently found out.

Since the profitable use of electricity depends on buying it and using it at a low cost, as well as using it intelligently, some cost problems merit attention.

Adequate wiring according to present code standards is too costly. The result is that farms are not wired according to code or are not wired at all. There is much room for improvement here, and to the ultimate advantage of all concerned.

It is common knowledge now that the way to get low prices is by large use, whether it be bread, buttons or electricity. From this standpoint the development of supplemental rural industries is of interest. The filling station, the country store, the roadside stand, the vegetable dehydrator, and, shall we say, the rural Tom Thumb golf course are types. It is another one of the problems which calls for a David.

The real human problem, which in the end is the most important of all, is the sociological and psychological effect of electricity on the farm people and on the nation. The increased income, the improved farm, the higher standard of living, the reduction of labor mean little if they do not bring happiness. Electricity also has the ability to bring this happiness directly in the better light, the radio, the home conveniences and the joy of possessing modern equipment. More attention might well be given to means for arriving at this end.

There are dozens of other problems demanding attention and which may be more within the realm of our facilities for solution but which cannot be mentioned here.

Following a recent report to the Rural Service Committee of the National Electric Light Association, it was decided to continue the analysis and stimulation of research work. Just how this shall be done has not been determined. It seems quite certain, however, that everyone concerned believes that the experiment stations and other established agencies should continue or enlarge their programs. It appears also that some coordinating agency for digging out and subjecting fundamental research to the absorption process of practical application is desirable.

In conclusion let me say that the electrification of agriculture is not a problem in the motorizing of an industry. Farming bristles with problems in chemistry, physics, biology, bacteriology, economics and sociology, all of which may be influenced to a degree through the application of electricity. While the adaptation of electricity to present farming operations is important, there is a need and an opportunity for forgetting some of our ingrained practices and sentiments about farming and the facing of the problems of agriculture with this daily solver of mysteries, unhampered by custom and prejudice.

Land Reclamation and the Farm Business[1]

By H. B. Roe[2]

WHERE do we go from here in land reclamation? To those upon whom rests the responsibility for the planning, direction and execution of land reclamation work, it is clear that the most pressing needs in reclamation, in its relation to the general public and particularly in relation to the farmer, are in extension and educational activities; for published evidence seems to indicate that a great many people in the United States are opposed to any reclamation activity whatever from the mistaken notion that it merely augments the surplus problem, that it menaces the stability of agriculture and that, therefore, in such matters as drainage, irrigation and the like nature should be allowed to take its unbroken course. This attitude of the public mind is largely the result of a mist of lack of understanding concerning the proper and necessary function of irrigation, drainage and related work that it should be our first care as reclamation engineers to disperse.

RECLAMATION NEEDS

Wholly apart from large reclamation projects in bringing extensive new agricultural areas under cultivation, we should maintain unceasing efforts to educate the agricultural industry to intelligent use of those phases of reclamation which apply to most of the individual farms already under cultivation and which have a definite and measurable effect in reducing the cost of production on these farms, thus tending to increase the margin of profit to the farmer, which after all is the important thing to be accomplished.

Neither time nor space available for this paper will permit of an exhaustive discussion of those phases of reclamation just referred to but to make the matter entirely clear it will be desirable, by way of illustration, to mention some of those phases which apply quite generally to farms in the seven states represented in the North Central Section of the American Society of Agricultural Engineers.

Supplemental Irrigation. Supplemental irrigation in the truck and fruit growing areas of the northern Mississippi Valley is coming into use more and more, of late years, as an effective insurance, both against untimely frosts and against short but destructive periods of drouth at critical periods in the crop season. A good understanding of the principle, cost, set-up, and operation of such systems is therefore essential to the agricultural engineer and there is a fruitful field of needed research in this line covering design, efficiency, duty of water, cost of operation, losses avoided by their use, and the like.

Land Clearing. Land clearing comes in for its share of consideration on existing farms, particularly in those areas where boulders and small patches of brush and scrub tree growth abound. The systematic use of explosives at comparatively slight expense removes these nuisances and permits the rectifying of field lines thus materially increasing the convenience of tillage and reducing its cost. This type of reclamation is being found of great advantage in profitable tractor farming in Minnesota, and I doubt not in Iowa and the Dakotas as well. Thousands of dollars of loss in injured or broken equipment and countless thousands more expressed in terms of drudgery and of nervous energy wasted might have been saved both by our fathers and by our own generation, in the years that have gone, by the occasional outlay of a few cents for three or four sticks of dynamite, five feet of fuse and a mud cap.

Soil Erosion Control. Every year sees thousands of acres of valuable and fertile land, in existing farms in all parts of the country, ruined along with the crops they bore by the ravages of soil erosion, the effects of which might at least have been partially mitigated by the application of certain well-tried yet simple preventive and control measures coupled with a little common sense in managing the field operations of seeding and tillage.

Drainage. There are very few farms in the northern Mississippi Valley that are not infested with small irregular areas too wet to cultivate until drained. Failure to remove these waste spots by drainage is a constant menace to economy of production on these farms because the existence of such spots, over or around which machinery must be moved, without return, with a considerable expenditure of time and labor, causes a marked increase in the cost of all field operations.

Many a promising field of clover, alfalfa, or grain has been ruined by winter-killing or prolonged surface flooding and waterlogging of the soil resulting from a chronically too wet condition that a little systematic under-drainage would have prevented.

It clearly appears, then, that the immediate job before us in reclamation, to the end of assisting in the solution of the present economic situation in agriculture is one of extension coupled with such simple, short-period, factual research, in any community, as will indicate the proper location for and type of effort that will give the best and most far-reaching results in the shortest time. In those

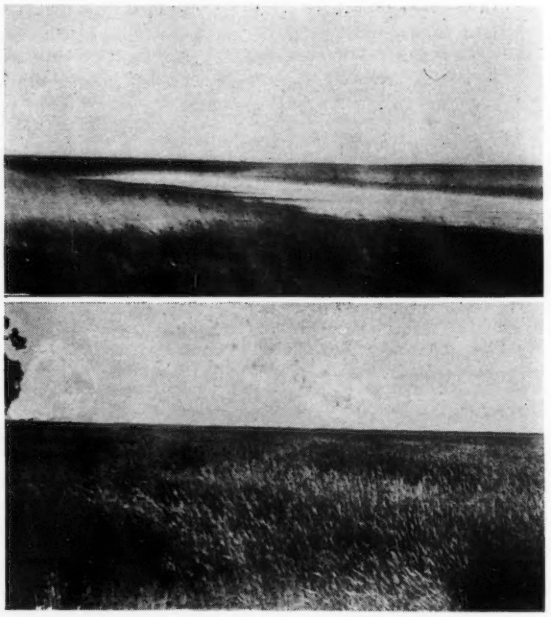


Fig. 1. Views on the Grandlin Farm in Traill County, North Dakota, opposite Halstad, Minnesota, during the heavy rainy period of June 1922. (Top) A drowned out quarter section of rye on undrained land. (Bottom) An exceptionally fine quarter section of rye immediately adjacent to the above but wholly underlaid by tile drains 200 feet apart and 3 feet deep

[1]Paper presented at a meeting of the North Central Section of the American Society of Agricultural Engineers at Fargo, N. D., May, 1929. Miscellaneous Series Paper No. 201, University of Minnesota, Department of Agriculture.

[2]Associate professor of agricultural engineering, University of Minnesota. Mem. A.S.A.E.

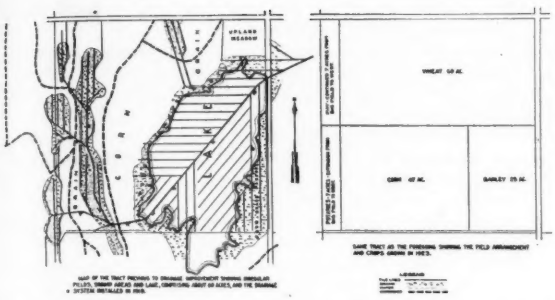


Fig. 2. A quarter section of a Clay County (Minnesota) farm showing influence of drainage in reducing number of fields and in straightening of field lines. (Left) Before drainage. (Right) The same area four years after tile drains were installed

states where extension work in reclamation is already established it should be maintained with conservative vigor along the lines herein indicated, and in other states where not yet active the campaign should be inaugurated and given an educational character calculated to disperse the mists of popular misconception regarding irrigation, drainage and the like, and to show the normal part they should and can play in the needed economic readjustment in agriculture.

PREPARATION FOR FUTURE NEEDS

So much then for reclamation activity that shall be immediately effective in the agricultural program; but we should not let our anxiety over present economic problems blind us to the equally great needs of the more distant future to meet which effectively we must prepare in advance. The Interbureau Committee on Land Utilization, in the valuable discussion of their findings presented in the U. S. Department of Agriculture Year Book for 1923 draw the interesting conclusions that during the next quarter century we shall need to increase our area under crop about 38 million acres, and that some 400 million acres of potential tillable land are available from which to select the added acres. They then add the further significant statement that a considerable part of this available land requires reclamation by drainage or other means. If the demands upon effective reclamation processes are to become so prodigious within the next twenty-five years, and if this demand is to be successfully met, needed research in the reclamation field must be speeded up very materially at the present time and for some time to come.

Most phases of scientific agriculture have made tremendous strides in the past twenty-five years. Research in reclamation has not however kept pace with other phases. Much valuable research has been carried out in irrigation, but knowledge of the essential facts in soil erosion control and in subdrainage is sadly lacking. Research in these fields is largely engineering in character and engineering research to be effective must be both thorough and unhurried. The problems demanding solution for efficient results in reclamation are many. In the course of our endeavor to meet present day urgent demands in our field, therefore, we will do well to reserve some time and thought for research vitally concerned with the more pressing problems of the future in reclamation.

PROGRAM FOR NEEDED RESEARCH

The general research problem in reclamation, for our district, naturally divides into four major groups. These are (1) supplemental irrigation studies as already outlined earlier in this paper; (2) the soil erosion problem; (3) the general problem of soil hydraulics, a fruitful and as yet almost wholly untouched field for research of the utmost importance because it bases the entire

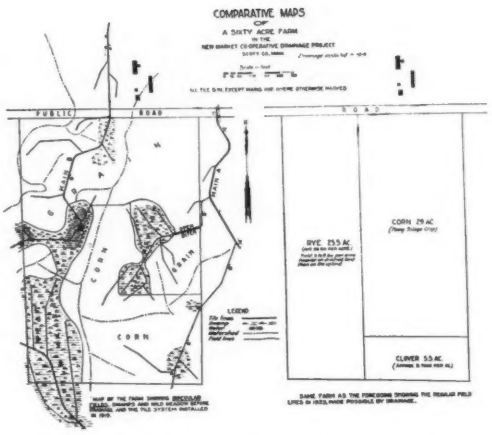


Fig. 3. Sixty acres of a Scott County (Minnesota) farm showing the influence of drainage in straightening field lines. (Left) The area before drainage. (Note the many irregular fields.) (Right) The area three years later showing one of many possible arrangements

work of irrigation and drainage; and (4) the purely economic problems of reclamation as particularly related to the financial success of the farming business.

A Study of Erosion Control Measures. The soil erosion problem must include, among others, studies of the erosive power of moving surface floods as influenced by soil type, by timber and other vegetable coverings, and by tillage operations; the extent of the controlling influence of subdrainage; and the best manner of terracing fields and reclaiming gullies. This broad field of research must involve the combined efforts of the agronomy, farm management, soils, and agricultural engineering groups. Provision for this line of research seems to be fairly well taken care of for the time being at least by the recent federal appropriation of $160,000, divided among the groups above mentioned and inclusive also of the federal forest service. However, as soil, crop, and climatic types are among the most influential factors in the erosion problem, it becomes, after all, quite largely local in its character. Therefore, the various states will probably find it necessary to aid the work of the federal department of agriculture by supplemental and check studies.

In the field of soil hydraulics, in the Mississippi Valley at least, those problems which concern drainage are well in the forefront and include particularly the following:

1. A study of soil permeability, which is one of the two fundamental factors determining the proper spacing and depth of tile drains according to soil type. It is purely an engineering problem in soil hydraulics, essentially local and empirical in character, and as yet almost wholly untouched by scientific research although three or four of the states are tackling it in a tentative and half-hearted way.

2. A study of the required rapidity of under-drainage according to crop type, which is probably the factor of greatest importance in determining the most efficient spacing and depth for tile drains. It is primarily a problem for the joint consideration of the agronomist, the horticulturist, and the plant physiologist, but the engineer must have the information readily available. He should therefore cooperate closely with the other groups. This is a wholly new and untouched field, a big and slow job, already too long delayed.

3. A study of the influence of catch-basins and surface inlets on the capacities of tile drains, which is purely an engineering problem in hydraulics, of general character,

one which should be delegated to some station, probably Iowa City, best fitted as to type of men and equipment, to handle it, and influence should be brought to bear upon the federal department of agriculture to support the work on account of its general applicability to all places and conditions of soil.

In the field of pure economics the land reclamation problems as yet untouched by scientific study are many. Especially prominent and important to the states comprising the North Central Section is the economic influence of tile drainage in stabilizing the farming enterprise (1) through insurance against loss of crop by prevention of drought, by checking of winter killing, by preventing excessive evaporation and checking of the soil and by warding off untimely frosts, and (2) through reduction of the cost of field operations by removal of wet pockets and sinkholes, thus enabling the rectification of field lines. (Land clearing activities also aid here.)

These economic problems should be solved jointly by the farm management and engineering groups. To date nothing definite has been accomplished. It is essential that there should be, for it could thus be clearly shown to all groups directly interested in agriculture that reclamation agencies are an effective help in stabilizing the farm business.

For effective results practically all reclamation problems must be studied over considerable periods of time and in an unhurried manner. Such study costs money, to obtain which we must look to the directors of our experiment stations who do not always recognize the importance of reclamation problems. A sound reclamation program should have the active support of the American Society of Agricultural Engineers.

Enriching Agriculture[1]

I VENTURE to deny, categorically and emphatically, that farmers are prevented from making profits because they are producing surpluses.

This is not an assertion that surpluses do not exist. It is rather a statement intended to pull away the curtains that have concealed a far more consequential truth.

What is really taking place is that the profits of too many farmers are being narrowed by their high cost of production. Surpluses do exist for high cost farmers; they do not prevent profits for low cost farmers.

Before we go further, let's define a surplus. So far as economists have been able to agree upon any definition, a surplus is that portion of a commodity in excess of the quantity that can be sold at a fair profit to the average producer.

The costs of production directly concern farm profits, for profit is the margin that spreads between cost and price. If surpluses at times bear hard upon the sale prices of agriculture's output, we may be deeply thankful that they do not stand in the way of the reduction of costs. In low cost methods lies the prosperous future of our basic industry.

Around the world today may be discerned few indications that we should expect materially higher prices for the products of agriculture than have prevailed over recent years. On the other hand, only the blind can fail to see that the costs of agricultural production can be curtailed by sweeping percentages.

The world has no supply in excess of its needs for either foods or fibers. Market seems always to be found, some place at some price, for all the non-perishable staples of agricultural production.

Some of the wheat grown in 1930 cost eighty cents a bushel to produce; doubtless some cost $1.20. The growers whose costs were thus high were beyond question victims of surplus. Some hundreds of thousands of bushels were grown for less than fifty cents, and even for less than forty cents. These low cost producers made a fair profit. Had former prices prevailed, their profits would have been tremendous. It can hardly be said that producers of wheat at less than forty cents suffered seriously from surplus, even under the price levels now current.

Not all this less than forty-cent wheat was made, as you might suspect, on the big farms of the Great Plains. A considerable quantity was produced, under accurate accounting, at below forty cents on small farms in the state of Iowa, where high yields compensated for other factors further west. If anyone is too much surprised at this fact I shall be glad to cite the source of the figures.

The production of forty-cent wheat under Iowa conditions should be sufficient evidence that low-cost wheat can be grown wherever in the United States wheat is an important crop.

Far more important is that such a demonstration, made under the conditions of 1930, supplies inerasable conviction that agriculture, instead of shuddering at the shadowy bogey of overproduction, should rather be engaged in intelligent attack upon its real enemy, high costs of production.

One would be appalled to contemplate the magnitude of agriculture's difficulties today if farmers were undertaking to compete with the world without the power and machines your industry has supplied. Machines have multiplied until it has been estimated that farmers have at their service power that would be the equivalent of 190 slaves per farm. The farmer who once was the slave of a patch can now be the master of a domain.

The tractor and the steadily improving battery of machines that accompany it, along with the superior horse-drawn equipment it has inspired, have advanced agriculture toward a new standard. For years farming has been spoken of as "both a business and a mode of life," by kindly men who hated to say just what kind of a business and what kind of a mode of life they really considered it. Modern equipment is taking off this curse by making farming a business in the best sense of the word, a business able to support an American standard of living.

No other agency has done so much to dispel the fear that rural population might drift and shift to a point where this nation's food might be grown by a population of peasantry. Tractors, multiple-row machinery, combines, and the scale of operations they involve, are utterly incompatible with any conception of peasantry.

Whether a farmer's profit is large or small, his total income is determined by his profit per unit multiplied by the entire number of units in his output. The acceptance of this fact is witnessed by the gradually increasing tendency toward larger farms. The industrialized farm, both family and corporate, steadily becomes more prevalent because the ideas here set forth regarding low cost and large volume have persistently won wider acceptance. I have elsewhere discussed the advantages of the corporate farm for bringing new capital into agriculture, and for providing expert management. We shall in the years to come witness the economic and social benefits of this development. Whether corporate or family farming shall prevail in the future, or whether as seems likely they shall develop side by side, makes little difference so long as the nation can boast an agriculture that is efficient and profitable.

This new generation demands to live better. Therefore it will farm better, will comprehend the opportuities of the new agriculture that is in process. This new generation will perform new wonders with your cost-cutting, volume-building modern farm equipment, and with the proceeds will enjoy a standard of living such as has never been known to a rural people in the history of the earth.

[1]Excerpts from an address by Wheeler McMillen, associate editor of the "Country Home," before the annual convention of the National Association of Farm Equipment Manufacturers at Chicago, October, 1930.

Control of Air Conditions in Potato Storages[1]

By M. A. R. Kelley[2]

POTATOES are a native food product and it would seem that the best method of storage and forms of storage would have been well learned by this time. In the early days small lots of potatoes were grown and the actual losses were small although the percentage of loss due to poor storage was often high. The production of potatoes has increased and large acreages now are grown in some sections. Each year thousands of bushels are put into storage at harvest time and held until railroad facilities permit of their removal or for change in price conditions.

In some sections the crop is stored in large warehouses having several thousand bushels capacity. Observations show that losses from mold, rot, etc., have been very large in many instances. These disappointing results are due principally to improper design and construction of the house, inadequate or no ventilation and to indifferent or unintelligent management.

This meeting is particularly an appropriate place for a discussion of this subject. New York ranks among the leading states both in acreage and in the production of potatoes. Including Long Island its climatic conditions vary more widely than any other potato-growing state and involve consideration of the requirements of three building zones, first, second and third, the last being the warmest as explained in Farmers' Bulletin 1393, entitled "Principles of Dairy Barn Construction."

It is not possible, in this brief paper, to give complete instructions for the construction of potato storages. No one design will meet the requirements for all sections because of the varying climatic and other local conditions. Handling methods during harvest, freedom from disease infection and state of maturity affect the keeping qualities of potatoes in storage. After the potatoes are stored our chief concern is with temperature, humidity, light and aeration.

The best storage temperature for potatoes is one that will keep the tubers in a dormant condition, preserve their edible qualities and vigor for seed purposes with a minimum loss from decay and shrinkage. The proper storage temperature is supposed to be in the neighborhood of 38 degrees (Fahrenheit). Careful investigations have shown that the freezing point of the potato is between 29 and 28 degrees.

The humidity of the storage room plays an important role in preventing excessive shrinkage from loss of moisture and losses due to disease. The skin of the potato should be kept dry in order to prevent surface molds and storage rots. The humidity should not be so high as to cause the deposition of a moisture film on the surface of the potatoes, walls or ceiling, or so low as to cause unnecessary shrinkage. It is advisable, during the first two or three weeks of storage, to reduce the temperature slowly and to maintain a high rate of ventilation. During the remainder of the storage season the humidity should be high enough to retard shrinkage and yet low enough to prevent undue condensation. Humidities of 65 per cent or lower will give rapid drying while those around 85 per cent will retard loss of moisture. Humidities above 90 per cent are not advisable as at this degree of moisture, and with a temperature of 40 degrees, a drop of but 2.7 degrees in temperature would cause condensation.

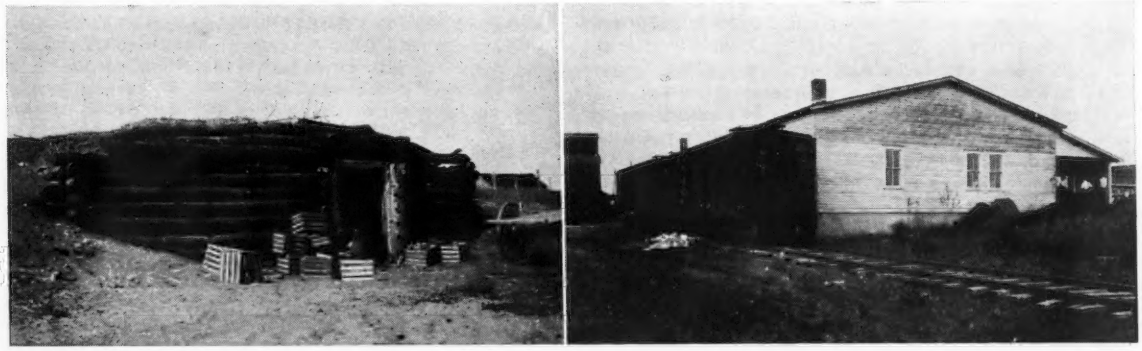
Potatoes, when exposed to strong or even moderate light, are soon materially injured for food purposes. The use of windows should be limited to those actually needed for working purposes and should be used principally in the grading or work room. Whenever feasible electric lights should be employed. It is difficult to control temperatures when there are a large number of windows in the storage.

It is necessary to make generous provision for ventilation in order to insure an ample supply of fresh air during the first two or three weeks. Tubers in the central portion of a large pile are frequently subject to overheating. This can be avoided by making some provision for aerating the pile. It is highly desirable to get thorough aeration of the potatoes through the piles as well as around them. It is bad practice to store in large piles or in bins having a depth of 10 feet or more as is sometimes done. They should not be piled to a depth of more than 5 feet without making provision for aeration of the center of the pile. Bins should not be over 8 feet wide and should have double-slatted partitions between them in addition to a false floor or dunnage which permits of circulation of air through the bottom of the pile.

The water content of white potatoes varies from 70 to 80 per cent, varying under different conditions of growth, and is much less than most of the fresh vegetables. Very meager data are available with respect to the respiration and transpiration losses of potatoes in storage. These show that the total shrinkage during the early weeks of storage is several times that of a month or six weeks later. They also show that the loss of solids by respiration is a small part of the shrinkage and

[1]Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers at Rochester, N. Y., October 1930.

[2]Agricultural engineer, U. S. Department of Agriculture. Mem. A.S.A.E.



(Left) This is an underground potato storage structure in Wisconsin. (Right) A trackside potato warehouse and storage in Minnesota

Poor management may easily nullify the advantages of a good house, but however skilled the operator may be he cannot accurately judge of the inside and outside air conditions and should be provided with a suitable and dependable instrument. The successful management of a well-built storage house is largely dependent upon proper operation of the ventilation system

that water constitutes the greatest part of the total shrinkage. The rate of water loss from potatoes is largely affected by external conditions. Little is known about the effect of the internal changes on the water loss during the different periods of storage and the rate of heat production at these periods.

Calorimeter measurements for the heat production of potatoes are not available; however, the following data, which were obtained by calculations made upon our request[3] will be of value in lieu of experimental data. During the respiration process, sugars and other organic compounds are converted primarily into carbon dioxide and water. It is assumed that at a respiration rate of one milligram of carbon dioxide per kilogram of product per hour, approximately 15 grams of sugar per ton of produce per 24 hours will be oxidized. The heat of combustion of sugar is about 16 B.t.u.'s per gram. Consequently, at a respiration rate of 1 milligram per kilogram-hour, a ton of produce in 24 hours will generate approximately 240 B.t.u.'s. Thus it is possible to obtain the approximate heat production when the respiration rate is known. The respiration of potatoes will vary from 3 to 8 miligrams of CO_2 per kilogram-hour with a consequent heat production of 720 to 1920 B.t.u.'s per ton per day.

The amount of moisture in the atmosphere varies. The amount which it can hold depends upon the temperature. The capacity of the air for moisture increases as the temperature increases and decreases as the temperature lowers. If the temperature is reduced beyond the saturation point the moisture is squeezed out or condenses in the form of tiny drops or dew. The amount of moisture in the air is expressed in terms of relative humidity. This term is used to express the relation of the amount of moisture the air actually contains to that which it is capable of holding at a stated temperature. When air contains as much water as it will hold, it is said to be saturated and is expressed as 100 per cent humidity. If the relative humidity is stated as 50 or 75 per cent, it means that the air at that temperature is 50 or 75 per cent saturated. The relative humidity of the atmosphere would normally be higher during the cooler part of the night than at noon when the temperature is higher.

These are the vital principles upon which the successful management of a storage house is dependent. There is much confusion with respect to their application. Some effort is required in order to fix these principles in mind. The writer, in another paper[4] which is available, has attempted to illustrate these principles so as to simplify their application to potato storages as well as to other problems of ventilation. Time does not permit of their repetition here.

In the primitive stage potatoes were stored in pits or caves, but in modern times of mass production we are concerned with two principal types of farm storages. The cellar type, partially or wholly underground and the insulated or above-ground type. The type selected will vary according to the locality and individual conditions.

Data are not now available to prescribe the limits for the most efficient operation or economy of each type. There is great need for someone to summarize all data on soil temperatures in order that the engineer may know what temperatures to expect, and we also should study further the heat conductivity of the various soils. When these data are known, the selection of the most efficient type to use will be greatly simplified. At present we can but suggest the cellar type as the dominating farm type in the first building zone, for moderate sized structures; both types for the second zone, depending upon the local conditions; and the insulated type for the third zone.

In the first zone the air temperatures during the storage period are frequently below freezing and some artificial heat will be required, although this should be avoided as much as possible since such heat tends to dry out the storage too much. Under such conditions the protection of an earth covering is of value. In the first zone air temperatures of the proper degree are frequently available to offset the heat effect of the earth's temperature. This is also true, to a certain extent, in the second zone but to a lesser degree, and intelligent management is required to balance the two sources of heat.

In the third zone the ground temperatures are seldom below the desired storage temperatures and the night air temperatures are frequently low enough to be utilized in lowering the storage temperature. In this zone it is impossible to lower the ground temperatures, hence insulation against the earth's heat is desirable as it permits greater efficiency in storage house operation. In such localities it is necessary to resort to refrigeration if late storage of seed or table stock in desired.

Underground storage under favorable conditions may cost less and be more efficient than above-ground storage, but at the same time less convenient of access and in some localities impracticable because of the character of the ground. The earth is an enormous reservior of heat. Even bare ground seldom freezes below 4 feet in most of the potato-growing sections, and the temperature 3 feet below the ground would seldom be below 50 degrees in most of these sections. When the storage is set below the ground there is a constant flow of heat through the walls and from the floor of the storage. When the house is above ground heat can enter only from the floor. If the walls that are above the ground do not readily permit the passage of too much heat, the storage temperature can be kept above freezing often with outside temperatures much below freezing. The amount of cold air required to reduce the storage air temperature is small as compared to that necessary to temporarily cool the earth floor surface. Hence more frequent and larger amounts of air are required to cool the storage where warm earth temperatures need to be counterbalanced. However, under such conditions colder air for cooling the storage may be used (judiciously) since there is less danger from overcooling or freezing of stock.

In the insulated house the ventilating air is required to cool the storage air, building and its contents without competing with the earth's temperature. Since, in the

[3]Courtesy of J. R. Magness, Bureau of Plant Industry, U. S. Department of Agriculture.

[4]Virginia Truck Experimental Station, Norfolk, Virginia, Bulletin No. 67, "Design and Operation of Commercial Sweet Potato Storage Houses," by M. A. R. Kelley.

A well-designed potato storage house in Maine. The top floor is used as a workroom and for storing machinery

third zone, the air temperatures may be below the desired storage temperature during but a few hours of the day, provision must be made for an abundance of ventilation and the house walls insulated so as to reduce the passage of heat in and out.

Properly insulated walls are essential particularly for the above-ground storage. Since the earth constantly supplies heat for the underground type of storage, greater heat losses may be permitted without dropping the storage temperature dangerously low.

The best insulators are those that contain the greatest amount of intrapped air; the smaller and more numerous the cells which are enclosed, the higher the insulating value. The air space as usually constructed in the walls has been, in the past, held in high repute for insulation purposes. The insulation value of such spaces are easily nullified by leakage through the usual loose construction. This general misunderstanding is being gradually dissipated. Careful experiments have shown that the insulating value of air space in tight construction is approximately constant for widths in excess of about one inch. Thus a 2, 3 or 4-inch space is but little more effective than a one-inch space. The insulating value of hollow masonry walls has been greatly overrated. If the air spaces are large, and particularly if they are arranged vertically in the walls so that convection currents readily occur, the insulation value is small.

The materials most commonly used to prevent or rather retard the passage of heat are the different varieties of cork products, mineral wools, hair felt, rock wool, vegetable fiber, either in the forms of insulating boards or flexible blankets, shavings, sawdust, etc., used in combination with wood, concrete or other masonry which furnishes the structural strength. Most of the common building materials are not good insulators with the exception of wood which possess both structural and insulating values to a large degree. Concrete made from stone aggregate provides very little insulation whereas cinder or porous concrete has insulating value 10 inches of ordinary concrete has about the same heat resistance as 1 inch of wood.

Dampness not only reduces their insulating value but favors the growth of molds and rots, first in the insulation itself and then in the structural members of the building. Most of the insulating materials in common use must be protected from moisture. Protection against surface abrasion and injury is often needed.

It is impossible to state the amount of insulation needed without assuming temperature conditions for a specific locality. However, in general the insulation value of storages range from the equivalent insulating value of 3 inches of cork to that of 7 inches. This value may be obtained by using any suitable insulator. It would seem most advisable, with respect to economy, to use only sufficient insulation to protect from the normal low temperatures of the locality. Lower temperatures than these may be expected occasionally and artificial heat will need to be provided in the cooler sections as a matter of insurance.

Attention should be called to the important point that the ceiling usually presents a larger surface than the walls. If the insulation of the ceiling is insufficient, moisture will collect on the surface and drop onto the potatoes below causing molds to develop.

Heat leakage is prevented or retarded by tight construction as well as by the use of insulation. Tight construction means tight joints around doors (avoid sliding doors) and all other openings at sills, plates, rafters, and wherever else air might enter or leave the building. Joints in masonry walls should be full and solid, sheathing should be matched and a good grade of building paper used. Cold air entering and warm air leaving the building through uncontrolled openings interferes with the proper control of storage temperatures.

Damp walls or ceilings in farm structures are commonly attributed to poor ventilation when very often the best cure is the use of insulation. This is a common fault in old barns which have been remodeled for common storage. If the barn floor is not to be used, 2 feet of well-packed hay or straw will give good protection of the contents of the cellar below. However, in many cases use of the barn floor is desired, and it is necessary to place the insulation on the ceiling below.

The control of air temperature and moisture is the most important consideration in the operation of a potato storage house. Since relative humidity is dependent upon temperature, it is obvious that the first step is to regulate the temperature. A tight, well-insulated house is essential and the operator must endeavor to anticipate weather changes, applying heat when necessary and adjusting the ventilating system according to the conditions within and without the storage. He must consider not only the temperature and humidity but the wind direction and velocity as well, in adjusting the size and location of intake openings.

Given a tightly built, well-insulated house affording adequate protection from the effect of weather changes and provided with means of supplying ample ventilation with control, the success of the storage lies, for the most part,

with the operator. Poor management may easily nullify the advantages of a good house, but however skilled the operator may be he cannot accurately judge of the inside and outside air conditions and should be provided with a suitable and dependable instrument.

The successful management of a well-built storage house is largely dependent upon proper operation of the ventilation system. Ventilator and air flues should be so arranged as to obtain rapid and even distribution within the storage. Intakes as well as outtakes will be necessary. The ventilation requirements will vary with the period of storage, much greater ventilation being required during the early period than during the dormant stage of the potatoes. There are reasons to believe that little ventilation will be required for seed stock during the later period, except that necessary to maintain suitable air conditions of temperature and humidity. Table stock will require more frequent ventilation than seed stock.

The use of long shafts and air ducts should be avoided. Intake openings should be provided on all sides in order to insure even distribution of air. Air intakes should be insulated in the first zone and part of the second so as to avoid frosted potatoes. In these zones air should be introduced at such points as to avoid freezing at such times as ventilation may be required during cold weather.

In the warm sections ventilating shafts are often inefficient, and in large storages it would be well to consider the use of fans when electric current is available. The greatest amount of ventilation will be required immediately after storage when fall temperatures in some localities will be comparatively warm and there is little difference between inside and outside air temperatures. In such sections the use of large entrance doors will be of considerable help in ventilating the storage, but they must be tightly constructed so as to retain the heat. Well-built antiwarping double doors should be used. In many cases vestibule entrances can be used to an advantage in controlling storage temperatures.

It is advisable to supply ample flue area so as to obtain a minimum of at least six dilutions per hour as based on local conditions.

There should be at least 2 feet of air space above the potatoes and a slatted floor is generally used to permit circulation of air beneath. The spacing of the slats in the partitions should not be so large as to catch the potatoes when shrinkage causes settlement of the pile. There should be not less than 6 inches of air space between the walls and the potatoes in the northern zone, and this space should be increased in the southern zones. Air drainage requires ample air ways, particularly in the corners where air pockets or sluggish circulation of air is apt to occur. Airways cut down the cubical storage capacity, but it should be remembered that lack of ventilation cuts down profits when potatoes spoil.

Control of storage temperatures is obtained by moving large quantities of air through the storage, introducing cool air at the lowest point of the building and removing warm air from the upper part. It is impossible to say how cold the outer air may be and still permit of direct ventilation through open doors. This will depend upon the ground temperature, rapidity of inflow and duration of ventilation. The air temperature of the storage may be changed quickly with a low outside air temperature, but the change in temperature of the stored stock will be much slower. Large masses of stock given off or absorb heat slowly. Under ordinary conditions it will be safe to ventilate freely under all temperatures down to 25 degrees, and an hour or two at a time down to 20 degrees. Accurate thermometers and sufficient in number should be used to give a true sample of the air conditions. When a change of weather is imminent, the house should not be left open at night or while the operator is absent.

If a high or low outside temperature continues for a sufficient length of time, the inside temperature will rise or fall according to the level of the outside temperature, whatever the amount of insulation used. If a low outside temperature prevails, the effect may be offset by the application of heat, but if the outside temperature be high, nothing can be done but wait for a favorable change. However, the effect of high outside temperatures is minimized by the use of insulation and the prevention of air leakage.

The amount of air required for good ventilation will vary with the conditions. Having adjusted the openings, the operator should closely observe the change of temperature and air movement in the various parts of the room and modify the setting of the inlet doors if necessary to get the desired effect. Wind velocity and direction must be considered as well as the air temperature. Experience will enable the operator to judge the outside conditions and set the intake areas accordingly.

Control of storage temperature is comparatively simple in respect to that of humidity which is limited to the intelligent use of the outside air conditions and to the knowledge the operator possesses of the first principles of humidity control. The introduction of outside air at a temperature of 5 degrees or more below that within will produce drying conditions in the storage, but when introduced at approximately the same temperature or slightly less, it will have little effect in reducing the humidity of the storage except as it is affected by the moisture production within the storage.

A small item but nevertheless an important one is that of the destruction of rats and mice which cause large losses by gnawing the potatoes and also by carrying disease spores from infected to sound stock. It is practically impossible to prevent the entrance of mice which are brought in with the potatoes, but it is essential that they be destroyed at the beginning of the storage period.

Experimental Cotton Gin to be Established in Mississippi

THE experimental cotton gin and laboratory authorized at the last session of Congress will be erected by the U. S. Department of Agriculture on a site made available by the Mississippi Delta Branch Experiment Station. Construction and equipment of the laboratory will begin at an early date in order that the experimental work may be started as soon as possible in the present season.

Through the efforts of agricultural engineers, fiber analysts, and agronomists the department expects to develop some of the fundamental principles of cotton ginning and cleaning and to promote a more exact understanding of relationships between the properties and conditions of seed cotton, the mechanical conditions of ginning, and the resulting quality of ginned lint. Recent development in methods of fiber analysis will be employed in measuring the effect of different conditions, both of seed cotton and of mechanical equipment.

Cotton growers and manufacturers as well as ginners and gin manufacturers have expressed their appreciation of the ginning studies to be undertaken and their desire to make use of information developed. The department believes that the improvement of ginning is a field in which the interests of growers, ginners, distributors and manufacturers are in complete accord, and it expects that the results obtained at the ginning laboratory will contribute materially to the improvement of the spinning quality of American cotton.

The Bulk Method of Handling Grain[1]

By E. N. Bates[2]

TWO distinctly different methods of handling grain are used in the United States. In the section east of the Rocky Mountains grain is handled in bulk, which might be called the mechnical means of handling grain. West of the Rocky Mountains grain is largely handled in sacks, which might be called the manual method of handling grain.

In the early history of the Pacific Coast grain industry, undoubtedly the sack method was the necessary method to use in handling grain. However, the time has long passed since this method has become obsolete and should have been discarded. Little progress was made in changing the method of handling grain from sacks to bulk on the Pacific Coast until the completion of the Panama Canal. The World War produced quite a change to the bulk method in the Pacific Northwest, where a number of the municipalities built large bulk elevators for the convenience of the grain industry. At the present time practically all of the wheat exports from the Pacific Northwest grain terminals are in bulk. Only about 35 per cent of the receipts at these terminals are in bulk, indicating that the farmers of the Pacific Northwest still handle their grain largely in sacks. Less progress has been made in California than in the Pacific Northwest in changing the method of handling from sacks to bulk.

In attempting to bring about a change in the methods of handling grain of a great grain-producing section like the Pacific Coast, the work naturally divides itself into three more or less overlapping stages. The first stage in such a change, if the facts are not available, is to conduct economic studies of the two methods to produce sufficient information to convince the parties interested that the change is desirable from an economic standpoint. When the accumulated facts indicate that a change is highly desirable for the well-being of the grain industry, the second stage is that of extension or giving publicity to the results and convincing those interested that the change should be made. Following the second stage of publicity or extension comes the engineering phase of the question, when it becomes necessary to design and build bulk handling equipment for farms, country shipping points and terminals. Various communities in the Pacific Coast section are going through one of these last two stages of development in the change from sack to bulk handling.

Effect of Economic Conditions. General economic conditions have a large effect on the tendency of farmers to favor changing their method of handling grain. I wish to mention a few of these conditions which at the present time have a bearing on the Pacific Coast question. The Pacific Coast farmer has for many years had a decided advantage over eastern farmers in the use of the combine harvester for harvesting his crops. This has to a large degree in the past offset the disadvantage of handling his grain in sacks. However, the combine harvester is now finding its way into the eastern grain areas and this advantage which has been enjoyed on the Pacific Coast will soon disappear, when the Pacific Coast farmer will find himself handicapped in the production of grain unless he discards his obsolete handling method.

Periods of low prices for grain tend to arouse new interest in farmers of the necessity of economy. At the present time the very low price of grain is having a tremendous effect on those farmers who are interested in reducing cost of production. This low price is apparently due to a strong competition for the export grain business of the world.

Effect of Cooperative Movement. Radical changes in the method of marketing the farmers grain are taking place in the United States. I refer to the cooperative marketing movement, which has made rapid progress under the encouragement of the Federal Farm Board. We are inclined to believe that the cooperative marketing of grain will undoubtedly cause some changes in the equipment and the methods that have been used in the past.

While the farmers' cooperative grain elevator of the East has been very successful in the past, still it has been a relatively small factor in the grain marketing world compared to what the present movement will probably become. These small elevators at country points have in the past been principally loading stations, machines to receive grain from trucks and deliver it to cars and no attempt has been made to store grain in large quantities.

If the present cooperative movement is successful in bringing practically all of the grain of the country into one organization instead of a number of small elevators under separate management in a community, there will be one large, well-equipped, efficient, well-managed elevator in each community. This consolidation should result in many economies and improved service. Such an elevator probably would be able to handle the grain of the community at a low cost. Under cooperative methods it is likely that grain will be, to a considerable extent, stored in these large country elevators until needed. These new marketing conditions coming at this time means that the Pacific Coast communities that are about to change to the bulk method of handling grain should be able to profit by this development and build elevators to meet their needs more completely than would have been possible under the old system of marketing. This tendency toward larger elevators has been noted in certain sections of the East for a number of years. Undoubtedly the building of larger country elevators has been started by the use in the East of the combine harvester which has thrown the grain into market in a much shorter period of time than was common with the old method.

Special Pacific Coast Problems. In designing a bulk-handling system for the Pacific Coast the agricultural engineer will be wise to study closely the question as it is handled in Canada and the eastern states and glean from their experience all the assistance that he can in order to shape an efficient system. However, we have some problems which are rather distinctively Pacific Coast problems. For instance, the very hilly country in the Palouse section of the Pacific Northwest where the land lies in great drifts of disintegrated lava, devoid of trees and stones. Because of the low rainfall these hills are seldom washed and they will produce grain on the steepest slopes. There is something of a problem here to harvest the grain satisfactorily in bulk. However, we find from investigations that grain is being handled in bulk on very steep hills in Montana and the eastern part of the country. Nevertheless when a Palouse farmer contemplates the change from sacks to bulk handling, he sees this as one of his greatest difficulties. With a little care and patience it should be possible to demonstrate to these farmers that grain can be handled in bulk on hills. Possibly the agricultural engineers in that section may be able to work out improved methods of handling grain on hills.

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[1]Paper presented at a meeting of the Pacific Coast Section of the American Society of Agricultural Engineers at Fresno, Calif., October, 1930.

[2]Senior marketing specialist, U. S. Department of Agriculture. Mem. A.S.A.E.

California has a problem in the bulk handling of high-quality malting barley which it is claimed needs the most careful handling to avoid injury. Practically all grain on the Pacific Coast is very dry and brittle when harvested and probably such dry barley is more susceptible to injury than barley of a higher moisture content. While we believe that the objection of handling this barley in bulk is rather largely unwarranted, still we are willing and anxious to have every care taken to avoid unnecessary injury of this product which demands a very substantial premium over feed barley in the export trade of the world.

Bulk Handling of Rice. California is a large producer of rice and the bulk handling of rice has its special problems. Rice is harvested at a time of the year when the weather is apt to be damp and the rice is apt to have a much higher percentage of moisture than is the case with other grains. For this reason it may be necessary to give special attention to ventilated bins for rice and even the use of rice driers for conditioning the rice. In fact our studies lead us to think that a very apparent improvement in the quality of rice can be accomplished by combining rice at the proper maturity and curing it in driers. By so doing the milling quality is considerably higher than that of rice that has been permitted to cure in the sun, which is the method of curing rice at the present time. Due to this tendency of rice to have a rather high percentage of moisture when harvested, it will probably be desirable to equip rice storage bins with thermometers in order to check up on the temperatures of the rice in bins. It will also be desirable to carefully avoid the mixing of other grains with rice as the mixing of cereal grains with rice is a very serious defect in the quality of the rice from a marketing standpoint. This will be especially true of those houses which handle both rice and other grains. In such plants screen conveyors should probably be avoided and all elevator boots should be made readily accessible so that the grain remaining in the boot from one handling can be entirely removed from it before the rice is run in the elevator. Of course, elevators for rice would have to be equipped with rice cleaning machinery, and if these elevators were used for both rice and other grains, they would have to have additional machinery suitable for cleaning such grains as it would handle. The rather wide difference in the harvesting time of rice and other grains makes an elevator serving both purposes more feasible.

ENGINEERING PHASES OF THE BULK HANDLING PROBLEM

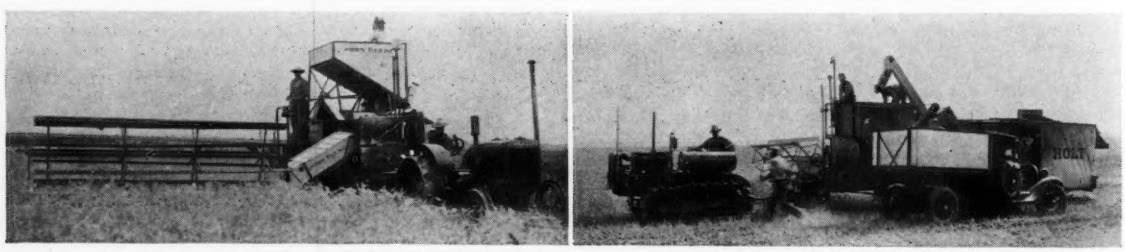
Bins on Combines. I would like to discuss some of the rather distinctly engineering problems which come up in the handling of grain in bulk. The design and construction of efficient means of delivering bulk grain from the combine to the truck is worthy of further study. There are numerous methods of accomplishing this now in use. The methods vary from running the grain direct from the combine into wagons that are hauled alongside the combine and must at all times accompany it, to the installation on the combine of large grain bins that will hold enough grain to load a truck or wagon in one dump. These questions bring into consideration the strength of the combine frame to withstand this added strain and the proper placing of the weight on the combine. In some cases this problem has been met by the construction of a trailer to be drawn alongside the combine, having the weight of the grain carried on a single extra wheel.

On combines that are harvesting on very hilly land it seems to be desirable to have the bins on the combines small and to make more frequent trips to take the grain from the combine to the temporary bin in the field. These field bins are called transfer bins and are used when it is economical to transfer the grain from the combine to the bin in small loads and haul the grain in longer loads from the bin to permanent storage, which is usually some distance from the field bin. If grain can be hauled direct from the combine to the country elevator, the use of the transfer bin is not necessary.

The design of deep bins for holding grain brings into use some principles which are not always thoroughly understood by the engineer who attempts to design structures for this use. Grain partakes somewhat of the nature of a liquid in that it will flow down hill, but in its pressure on the walls of containers it varies a great deal from the hydraulic pressures of liquids and for this reason there have been numerous failures in the walls of grain bins. There is an interesting circular known as Department Bulletin No. 789 on this subject issued by the U. S. Department of Agriculture, entitled "Pressures in Grain Bins," which I would like to recommend to you. Ketcham's work, entitled "Walls, Bins and Grain Elevators," is a classic on this subject.

From this analysis it is quite apparent that except in shallow bins a large part of the weight of grain is carried as a vertical load on the walls of the bin. The grain adjusts itself when the bin is being filled so that the walls are not apt to show the effect of the load until the grain is being drawn from the bin. At that time the pressure from underneath is released, the grain tends to arch over, bringing the full weight to bear on the side walls near the bottom of the bin. If the vertical strength of the wall is not sufficient to withstand this pressure, the walls will fail from compression or buckling and the bin be destroyed, with the consequent loss of the grain and danger to life. In metal bins this load produces a corrugation around the bin and simply causes the bin to buckle and deform. When the discharge opening in a bin is at the side of the bin, this condition is aggravated. Metal bins are sometimes stiffened by vertical angles or channels.

The Elevator Leg. The whole bulk handling system is based on the invention of the bucket elevator leg. This in its simplest form consists of an endless belt with buckets attached running over suitable pulleys located one directly over the other. In operation the buckets dip into



Grain growers in general on the Pacific Coast have been slow to give up the sack method of handling grain from the combine. However, those who have given the bulk-handling method a fair trial are very much converted to it. The present economic situation bids fair to stimulate general adoption of the latter method

the grain and carry over the upper pulley, throwing the grain into a trough from which point it flows to the various machines or bins. This elevator leg is a very important part of the bulk handling plant and deserves careful study. The elevator belt speed is so chosen that the grain as it passes over the upper pulley is thrown by centrifugal force entirely free of the cups and with just sufficient velocity to drop into the receiving hopper at the head of the elevator. This requires a rather definite rate of speed for each different size of the head pulley. These speeds have been worked out quite carfully and I have prepared a chart to show the relation of the revolutions per minute of the head pulley to the diameter of the head pulley and the travel of the belt in feet per minute. Manifestly the larger the head pulley the faster the belt and buckets may move and consequently with the same sized cup and spacing on the belt the more grain will be elevated.

Elevators of the belt and bucket type are always driven from the head pulley. From the theory of belt transmission you will understand that thus arranging the drive at the head pulley the minimum amount of pressure will be produced on the bearings. As the ratio of the weight of the buckets full of grain to empty buckets on the down side of the belt is considerably more than the ratio for belt transmission of power, it is necessary to increase the tension on the slack side of the belt. This is most simply done by forcing the pulley in the boot of the elevator downward, thus adding equal tension on the two sides of the belt, until the proper transmission ratio is reached. Failure to do this in most cases would cause the drive pulley to slip under the belt and would result disastrously.

Until a few years ago the adjustment for the tension of the belt in the boot of the elevator leg was made by means of screws which forced the pulley bearing down so as to cause the belt to become tight. In recent years, however, automatic devices have been used which consist of weights placed on the bearings in such a way that there is a constant and uniform added tension in the boot pulley.

Large elevator heads are provided with an automatic back-stop which, if there is a failure of power while the elevator is in operation, will prevent the belt from running backward. If the loaded belt reverses and runs in the opposite direction, clogging results, making it impossible to start the elevator until the accumulated grain has been removed from the boot of the elevator. In small elevators this is not serious and backstops are usually omitted.

Insurance Rates. Wooden elevators are quite a fire hazard and every possible precaution should be taken to prevent fires starting in wooden elevators. It is just as true that all consideration possible should be given to those things in an elevator which make for low insurance rates, regardless of whether construction is sheet metal, concrete or wood, for frequently a very small change in an elevator will reduce its insurance rate all out of proportion to the small expenditure required.

Grain Dust Explosions. Dust explosions are a serious menace to grain elevators. However, most of the dust explosions that have resulted in such serious destruction of life and property in this country have been in the larger plants. Relatively few dust explosions are recorded in small country elevators. This may be explained in a number of ways. Possibly the dust that accumulates in the country elevator is not as explosive as that which accumulates in the large grain plants. It is also quite plausible that the country plant being small has better ventilation and the dust does not accumulate as it does in a large plant where ventilation is not so good. The dust explosion hazard can best be coped with by a thorough understanding of what a dust explosion is and what the conditions are that make an explosion possible.

The U. S. Department of Agriculture, through its Bureau of Chemistry, has issued a bulletin, entitled "Dust Control in Grain Elevators," Department Bulletin No. 1373, which has many helpful suggestions to anyone interested in having a dust-free plant.

In the design of elevator workhouses it is at the present time recommended that the outside walls be made as light as possible to permit of their blowing out, easily causing a minimum amount of damage in the case of an explosion. The most serious damage from dust explosion occurs in elevators where the structure is so rigid that the pressures build up to a destructive point before anything gives way to relieve the pressure.

Federal Grades and Elevators. The federal grain standards have much to do with deciding what equipment should go into elevators for the efficient handling of grain. Accurate scales naturally are required in all plants. Machinery for conditioning the grain to give it the highest market value is essential in practically all bulk handling plants. This machinery depends upon the defects that the grain of the particular community in question may have. A knowledge of the method of overcoming these defects is very essential when it comes to the recommendation of adequate machinery. The cleaning and blending of grain is something that must be provided for in the large elevators. Grain must be kept cool and sweet and free from infestation. In the design of a grain plant it is very essential that a high speed of handling be one of the features of the plant. All machinery must be adequate so that there will be no bottlenecks that will hold up the rapid flow of grain through the plant.

Recent Bulk Plants. You may be interested to know that in the addition to the Portland municipal bulk elevator one million bushels of reinforced concrete bulk grain storage was poured in practically seven days. This is a very rapid building of such an immense storage of grain. The new municipal elevator at Tacoma, Washington, has a feature about it that is new, we believe, and that is the location of the workhouse in the middle of the height of the elevator. This permits storage bins to be located above and below the workhouse. In previous designs it has been customary to locate the workhouse either above or underneath the workhouse bins.

By locating the workhouse thus with bins above and beneath it, the machines for conditioning the grain can be run without using an elevator for each machine. This same idea was followed in the new Fisher flouring mill elevator at Seattle, Washington. Incidentally, this new plant is one of the most up-to-date plants that we know of and many interesting and original ideas in the application of electric control to the handling of grain have been worked out successfullly in this plant.

In conclusion may I suggest that the present economic situation bids fair to be stimulating to the bulk movement on the Pacific Coast and we expect that, unless there are some unforeseen changes, the demand for bulk facilities on the Pacific Coast will increase rather rapidly in the next few years. With the forces that are involved in the grain marketing field at the present time, we see no good reason why the change from sacks to bulk should not take place rather rapidly and be fairly well toward completion within the next few years. The universities and the agricultural colleges of the Pacific Coast are giving attention to this subject. The economists of these institutions are studying the problem, the extension service is willingly carrying the message of economic saving to the farmers, and the agricultural engineering divisions are putting much time on studies of equipments and methods of assisting the farmers to make the change from the sack to the bulk method. The farmers themselves who have used the bulk method, are interested in bettering the condition of their industry and have banded together in California to assist their neighbors in making this change. This universal approval of the farmers who are handling their grain in bulk is one of the most hopeful and convincing arguments in favor of the movement.

The Scope and Purpose of the Agricultural Engineer's Work[1]

By William Boss[2]

AGRICULTURAL engineers hold the unique position of applying to agriculture, that is, to the work of producing the raw materials for food, clothing and shelter, those forms of power and industrial management that have revolutionized the commercial industries of America in recent years.

The development of agricultural engineering has kept pace with civilization which has now reached a point where man is being relieved of much of his former burden of physical labor. Men of today are rapidly attaining a position where they are either directing the work of others or are using mechanical power and machinery to assist in the accomplishment of their tasks and those of others. Thus they are gradually eliminating drudgery from labor.

Why do we work? Why does some work seem difficult? Why does some work become drudgery? Why do we enjoy work which does not seem to us to be drudgery? These questions have been asked for ages, and they will continue to be asked in the future until education gives man a more complete understanding of his own life processes and points out more clearly for his guidance the fundamental laws of nature.

We should not accept too literally the Biblical statement "In the sweat of thy brow shalt thou eat bread." Many believe this to mean that drudgery is the inevitable lot of man. Perhaps it is, but if so hard work should develop his thinking capacity as well as his muscles. However, the Creator has given man a superior type of mind and it is evident to me that man is to be rewarded for using and thus developing his intelligence by finding methods for relieving himself from the drudgery of labor.

In support of this theory the engineer may point to the fact that the present development of civilization is largely due to the right use of the forces and materials of nature, and that right use has been brought about largely by engineers, a group of men having a knowledge of the sciences together with inventive talent and the vision which blazes the trail to success for the engineer.

Engineering has been defined as "the science of controlling the forces and utilizing the materials of nature for the benefit of man, and the art of organizing and directing human activities in connection therewith."

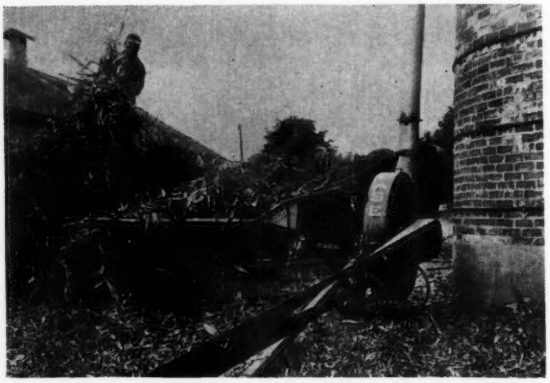
The natural forces with which the engineer is especially concerned are heat, light, gravity, chemical activity, animal power, and electricity. The materials of nature are air and other gases, water, wood, minerals and metals, rock and clay products, petroleum, food and clothing materials. Man's study of these forces and materials leads him to strive for the better things of life for himself and develops within him, in a measure, a desire to establish among men an understanding of and obedience to the laws of nature which will lead to higher standards of living and thus extend man's state of happiness.

Agriculture has long been considered basic. Before the period of even primitive agriculture, man gathered his food raw and ate it uncooked as did the animals, but through the development of his intelligence he learned to plant the seed, to till the soil, and to domesticate wild animals, thus setting up the beginnings of the science of agriculture or the production of food as an industry. In this process he was simply, in a measure, controlling and directing the growing and breeding forces of nature which exist without his volition.

Farming is a necessary occupation through the scientific development of which man has become able to produce more than he can consume. This development has enabled him to take some time to enjoy life. This result in time has lead to a wish to be able to do his work to improve his living conditions. Such evolution resulted in the inventive mind. No doubt it was the man with an inventive type of mind, the dreamer, the man with the ability to look backward for facts and with the vision to look forward with understanding, who found the easier way of doing his work, perhaps by using a tool or an implement. This man was probably the first agricultural engineer—the first to make a tool from the materials of nature for the benefit of man. No doubt it was this type of man that made the first farm implement and the yoke for the ox, thus increasing his efficiency or productive power and adding to his wealth and reducing his labor by the use of animal power.

There seems to be but little authentic record of the development of the tools and implements used in agriculture. Farmers have frequently ridiculed those endeavoring to develop machinery adapted to agriculture. When Charles Newbold, of Burlington, New Jersey, in 1797 patented a plow made almost entirely of iron, the farmers rejected it on the theory that so much iron drawn through the soil poisoned the soil, and not only retarded the growth of plants but stimulated the growth of weeds. However, science in time dissipated this superstition, and in 1837 John Deere of Grand Detour, Illinois, built the first steel plow from an old saw blade. This plow was the forerunner of the modern plow and in it a wonderful step was made in the progress of agriculture. John Deere may well be considered a pioneer among agricultural engineers.

Another farm bred man of the engineering type was Cyrus H. McCormick, who was born on a farm in Virginia in 1809. Working on this farm with his father, Robert McCormick, who suggested the idea, in 1831 he made in their home blacksmith shop the first successful



Owing to the influence of mechanical power and machinery farming is ceasing to be a mode of life and is becoming a business comparable to that of any other industry

[1]An address before a meeting of the North Central Section of the American Society of Agricultural Engineers at Fargo, N. D., May, 1929. Miscellaneous Series No. 202, University of Minnesota, Department of Agriculture.

[2]Chief, division of agricultural engineering, University of Minnesota, Department of Agriculture. Charter A.S.A.E.

Engineers are not thinking of solving the world's problems alone; they are willing and eager to help make and execute plans calculated to bring peace and prosperity to all people

reaper, hewing out the wood and forging out the iron by hand. He was scoffed at and ridiculed at first and business came very slowly. Even in 1851 twenty years later, the British newspapers referred to his invention as a cross between a chariot, a wheelbarrow and a flying machine. The rapid spread of farming over the Middle West, however, created a demand for the reaper, and the modern self-binder which grew out of it stands as a lasting monument to the man's indomitable perseverance, courage, and ingenuity.

Very few reapers are sold at the present time. They have been almost replaced by the self-binder, now in its turn gradually giving way to the modern combine which is being exported to all parts of the world. The reaper was to the combine what the ox was to the horse, the dasher churn to our modern creamery, the tow boat and the canal to steam and electric railways, the bicycle to an airplane, and the telegraph to radio.

All these developments have been brought about through the training of man's intelligence caused by his study to control the forces and utilize the materials of nature for the benefit of himself and others. Such a work is quite as valuable as that of making two blades of grass grow where only one grew before, a result in itself of no great service unless there is need for the second blade of grass. Man did not create the second blade of grass any more than he did the first one. He only prepared the seedbed, planted it, and cultivated and protected the growing plant. Surely the engineer who controls the forces and utilizes the materials of nature in such a way as to enable one man to do the work previously requiring two or more men is entitled to equal credit with the grower of the two blades of grass, because the man so released should be of more value to industry and to society than is the extra blade of grass, and his existence is of more value to those engaged in farming because he is a consumer of the products of the farm, providing he himself can find productive work at something other than farming. The fact that so many men have been engaged in the past few years in work other than farming—mining; building factories, homes, schools and churches, and designing and making machinery, highways, electrical equipment, airplanes, railways, and amusement facilities—has enabled the farming industry to dispose of its produce at much higher prices than probably would have been obtained had there been less employment in other lines.

A successful engineer must have a general knowledge of mathematics, physics, chemistry, economics, accounting, law, etc., and above all he must be able to make the practical application of these sciences to the particular work in hand. He is unconsciously also an economist and a financier, as he is first of all confronted with the cost of his endeavor and the question as to the financial returns to be obtained from it both by himself and by his client.

The work of the agricultural engineer has thus far been largely confined to applying the technical phases of engineering to agriculture, especially those pertaining to land reclamation, structures, and machinery. The developments in these lines have been very rapid and they have presented many new problems, in most of which it has been necessary to change the method of doing the work or to increase the volume of the business in order to provide sufficient volume of work to justify the initial expense and insure an income from the investment.

Present indications point to the probability of larger farm units or to cooperative operation under the direction of an agricultural engineer assisted in carrying on the routine work by men having special training in livestock or crop production. Nature does not give to all men the same natural talent, and each one tends to follow the line of work in which he has the greatest natural interest. The engineer usually has initiative, or inventive ability, a vision to look ahead, and he must be able to apply to his particular job the latest information that proves to be reliable and useful.

As a rule changes in any line of business do not come from those directly engaged in that business, but they come from developments in other lines of business which are being adapted gradually to new applications. Most changes take place rather slowly. Nature usually gives signs of warning to prepare us for changes and to enable us to profit by the use of our intelligence. Often such a warning leads to careful thought and to a change in methods or of occupation which generally brings much better returns for our efforts. There should be no present cause for alarm on this account.

At this time there seems to be a surplus of agricultural products at moderate prices. This indicates that future prosperity depends upon keeping other lines of industry busy at fair wages. The farmer has helped to do this in recent years by purchasing machinery and other manufactured products that should make his work more agreeable and his life happier. The building of better buildings, installation of water systems or heating systems, or the purchase of equipment tends to induce other farmers to do the same. While the amount spent by one farmer may not be great, the aggregate does a great deal towards keeping industry employed and thus helps to maintain the prices of farm products as well as to hold down the surplus.

Owing to the tremendous expansion resulting from the use of mechanical power and machinery by those engaged in agriculture, farming is ceasing to be a mode of life, and it has become a business comparable to that of any other industry. This is made quite evident by noting the development taking place in the production of such agricultural products as coffee, sugar, tobacco, cotton, etc., and by the changes taking place in the manufacture of butter, in the canning of vegetables and in the operation of our modern meat packing plants. If the present trend of efficient and economic production continues and keener competition develops, it is quite possible that the near future will find meat packers, butter manufacturers, and operators of canning factories owning or controlling their own farm lands and producing their own raw products. This is exactly what has happened in the case of one prominent automobile manufacturer, in spite of the fact that he was able to raise his wage scale and develop his business at one and the same time while proving to some of the bankers and agricultural advisers that it was good business for the farmer to have an automobile, a tractor, and perhaps even a truck, providing he used good business judgment in carrying on his activities.

Too often do we overlook the fact that manufactured articles are made from natural materials which in their original state are practically worthless, and that the chief cost of the finished product results from the labor involved in the processes of mining, refining, and machining the metals, in the manufacture of the article, and from

the transportation and distribution of the raw and the finished product.

Industrial labor is one of the very best consumers of agricultural products, for the industrial workers are good buyers as long as they have employment at good wages. The right use of power and machinery should result in shorter hours of labor, a higher wage scale and a more agreeable task for those who labor. These conditions can only be obtained when each individual realizes his own personal responsibility and spends his earnings in such a manner as will tend to expand industry and give profitable employment to those in need of employment.

The future problem of American agriculture is to be able to produce its food and clothing products at the lowest possible cost in order to meet foreign competition. Foreign nations are sending their representatives to this country to study our methods and our machinery. In addition to buying our farm machinery, they are starting their own factories and building their own. This fact together with their relatively low wage scale indicates a much larger surplus problem eventually. The solution lies in inducing other and constantly new types of employment at good wages and the devoting of more time to education, music, and recreation of the right kind, thus establishing high standards of living and increasing the consuming power of the individual.

To the end of lowering the cost of production in agriculture, there is a great need for more information along agricultural engineering lines. Our agricultural colleges and experiment stations should give constructive thought to the engineering phases of their work in order to assist in bringing about better living and working conditions for those engaged in agriculture, at least comparable to those in other industries.

Agricultural engineers have rendered great service in the development of the present tractor in establishing standards such as the Nebraska test, setting up standards whereby definite comparisons of efficiency of tractors are determined. An examination of the "Transactions of the American Society of Agricultural Engineers" and of its technical journal "Agricultural Engineering" reveals a wonderful progress in agricultural engineering, in various similar ways since the organization of the Society twenty-two years ago.

Among the important lines of technical research being carried on by agricultural engineers at the present time are the study of the combine harvester and of grain and hay drying equipment, the development of efficient and economic tillage methods, the control of weeds, land reclamation(including land clearing, drainage, irrigation, control of soil erosion), and the design and construction of farm buildings embodying convenience, economy, efficiency and durability.

Another important work of agricultural engineers is the development of practical courses of instruction in agricultural schools and colleges. This involves teaching both the practical and scientific application of many new methods and devices which have been in use only a few years.

The engineer is not thinking that he alone is able to solve the world's problems, but he is offering his service as one willing and eager to help make and execute plans calculated to bring peace and prosperity to all people.

The work of the engineer in addition to developing his knowledge of the sciences and the technical phases of his profession brings him in contact with many groups of persons involved in our American life such as farmers, land owners, bankers, merchants, manufacturers, educators, social workers and public officials, many of whom are prone to limit their activity to their own special group. The engineer's activities, therefore, place him in a position where he is forced to study the related activities of many groups and to plan his work in a broad and comprehensive manner. This study and application develops within him a spirit of leadership in those ideals and activities that tend to right living, good citizenship, and national progress. Thus he fulfils his destiny "in organizing and directing human activities . . . ."

Professional Responsibilities[1]

SINCE a profession must so largely govern itself, it is assumed to maintain certain codes:

1. A code of qualifications governing admissions
2. A code of ethical practices in relations with clients
3. A code of professional honor in internal relationships
4. A code of public obligations

Professional status is therefore an implied contract to serve society in consideration of the honor, rights, and protection society extends to the profession. Through all professional relations runs a threefold thread of accountability to colleagues, to clients, and to the public. Business moves toward the professional area as its management passes from proprietors to a distinct administrative caste with little or no immediate stake in the profits of trade. In so far as the rewards and status of this caste rest on long-range prosperity rather than quick returns, it is able to maintain the attitude of accountability to investors, workers, customers, and the public, which is the irreducible element in professional standing. Whatever of social loss has resulted from the blurring of the engineer's personal status, has been largely offset by what he has contributed as an administrator to the professionalizing of industry.

The obligations of a profession are so much a matter of attitude that codes alone are not sufficient to sustain them. Equal importance attaches to the state of mind known as professional spirit, which results from associating together men of superior type, and from their common adherence to an ideal which puts service above gain, excellence above quantity, self-expression above pecuniary incentives, and loyalty above individual advantage. The professional man cannot evade the responsibility to contribute to the advancement of his group. His skill rightly holds as a personal possession, and when he imparts it to another he rightly expects a due reward in money or service. His knowledge, however, is to be regarded as part of a common fund; hence the obligation to publish researches and to share advances in professional practice. If his abilities do not permit him to do so personally, he can at least pay his debt by contributing financially to the dissemination of the works of others.

Many engineers need to be warned away from too short-sighted an attitude in this matter. There are doubtless thousands of us to whom the immediate, tangible value of the publications of a professional society is much less than their cost, yet when one pauses to consider the magnificient body of knowledge which has been accumulated as a common heritage through this channel, our tax for the benefit of the art is actually nominal.

The protection of professional standards and the enhancement of professional status is a prime duty of the profession itself and ought not to be allowed to pass by default into political hands, or into forms little calculated to enhance the dignity and prestige of the engineer. There is a certain appropriateness in the advocacy of this cause by one connected with the educational arm of the profession. What the colleges are waiting for is a challenge from the profession, not merely to perfect their present undergraduate courses, but also to attack in earnest our next great problem, the after-college education of the engineer.

[1]From the "Professional Status of the Engineer," by W. E. Wickenden in "Civil Engineering," Vol. 1, No. 1, (October, 1930).

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted should be addressed direct to the publisher.

Ultra-Violet Light and Plant Production [trans. title], J. Reinhold and F. Schulz (Gartenbauwissenschaft, 2 (1929), No. 1, pp. 40-78, figs. 14).—Experiments at the Dahlem Horticultural Station with various plants grown under ultra-violet, common window glass, and crude glass gave varying results. Based on 100 per cent yield for plants under the crude glass the maximum yields under ultra-violet glass for radish, spinach, lettuce, bush beans, cauliflower, melons, tomatoes, and carrots were respectively, 110, 123, 107, 131, 95, 96, 109, and 95 per cent. The rooting of tomato and Cotoneaster cuttings were slightly less under ultra-violet glass. In the case of the tomato early ripening was stimulated by the ultra-violet glass. Records taken on the temperature under the three types of glass showed slight differences which were overcome by ventilation. It is suggested that the differences in responses of the various plants may have been due to their behavior under various light intensities.

Methods of Harvesting Grain Sorghums, J. H. Martin, L. A. Reynoldson, B. E. Rothger and W. M. Hurst, (U. S. Department of Agriculture, Technical Bulletin 121 (1929), pp. 35, figs. 18).—The methods used in harvesting grain sorghums in southwestern Kansas and northwestern Oklahoma were studied in cooperation with the Kansas and Oklahoma Experiment Stations and the Kansas Engineering Experiment Station during the season of 1926. Milo and kafir were the principal grain sorghums grown. Two general types of farming, viz, wheat growing on the heavier soils and grain sorghum and broomcorn growing on the sandy soils, are practiced in the area investigated. Very few livestock except work horses are kept on the farms. Nearly half of the farmers owned tractors, and about one-fourth of them had trucks.

Much of the milo and some of the kafir was headed by hand. The machines used for harvesting grain sorghums included row binders (corn binders), grain headers, combines, special kafir headers, and grain binders. Nearly half of the farmers used two or more methods of harvesting in 1926. The largest average acreage was cut with grain headers and the smallest acreage with the row binders. Kafir seemed to be better adapted than milo to machine harvesting. More than half of the grain sorghum was harvested before frost.

The losses from heads left in the field averaged 10.9 and 6.4 per cent, respectively, for kafir cut with the combine and the grain header and 25.9 and 13.5 for milo (Dwarf and Standard). The losses in harvesting with the row binder were small, and those in harvesting by hand were inconsequential. Many of the farmers picked up the loose heads.

Most of the combines were drawn by tractors. The combines with a cut of 12 to 16 feet required about 10 horses or a tractor of about 15 drawbar horsepower to pull them. About 1.6 gallons of fuel and 0.1 gallons of oil per acre were used in harvesting with a tractor-drawn combine equipped with an auxilliary engine. A gallon of fuel (gasoline or kerosene) per acre was consumed by the tractors, and 0.6 gallons of gasoline was used by the combine engines.

One man with a team headed by hand and ricked an average of 1.8 acres of grain sorghum, two men with a grain header and 8 or 10 horses averaged 13 acres, two men with a 15-foot combine harvested and threshed an average of 23 acres, and two men with a row binder and four horses cut and shocked an average of 5.9 acres per day. Three or four men with a combine threshed an average of 200 bushels or more of headed grain sorghums per man per day. Five and six men with a separator threshed about the same quantities per day. Headers, combines, and separators were found to require considerable adjustment for the proper harvesting and threshing of grain sorghums.

Harvesting and threshing grain sorghums cost 3 cents per bushel with the combine, 8 cents with the header, 15 cents with the row binder, and 10 cents when harvested by hand. While cash costs are lower for the combine than for other methods of harvesting, this low cash cost is made possible only through the purchase and upkeep of an expensive machine.

Of 147 growers with grain sorghums harvested and threshed by all methods, thirty piled the grain on the ground, eighty stored in bins, eleven piled the grain on the ground and later stored in bins, and twenty-six hauled the grain directly to the elevator. Piling on the ground was the most effective way of drying the grain before marketing or storage.

Combined grain sorghum contained more moisture, foreign material, cracked grain, sand, and dirt than that headed and then threshed from the ricks. The average moisture content of grain sorghum harvested with a combine before frost was slightly higher in kafir and in milo considerably higher than that in grain harvested after frost.

Horses, Tractors, and Farm Equipment, J. A. Hopkins, Jr., (Iowa Station Bulletin 264 (1929), pp. 273-404, figs. 6).—This is the second bulletin reporting the results of the study previously noted. Tables and graphs are included showing the averages, by years, 1925-1927, and for selected farms in 1927, for the number of work and other horses, hours of work and crop acres per horse, and net horse, tractor, and total power costs per acre; variation in acreage per horse and cost of horse work and all power cost per acre on farms of different sizes with horses only and with horses and tractors; feed requirements and net expense per year of keeping a horse; fuel consumption and expenses, by items, for tractors; variation in tractor use with size of farm; variation in per hour cost for tractors with different amounts of use; variation in horse performance on tractor and nontractor farms of different sizes; equipment on farms and acres handled with different farm machines on farms of different sizes; time required to perform different farm operations with tractors and different numbers of horses and different size machines; average investment in crop and livestock equipment for different size farms; investment needed to equip farms with 100 and 150 acres in crops; and the annual equipment purchases for farms of different sizes.

The study showed the following facts: The acreage per horse on tractor farms increased from 12.5 with 80 acres of crops to 25 with from 120 to 150 acres of crops. The expense per year of keeping a horse was from $60 to $110, $90 being typical. Of this expense about 75 per cent was feed. A tractor seemed to be profitable where it permitted the number of horses to be reduced by three. The expense of tractor use generally was about $1 per hour if the tractor was used less than 300 hours per year. The investment in equipment was $14 per acre for farms having less than 80 crop acres and $7 for those with over 160 crop acres. Annual equipment expense varied by about $1.60 per acre for the two groups of farms. Considering man labor, the two-bottom, 28-inch plow with 5 horses, and the 9-foot disk, 20 or 20-foot harrow, and two-row cultivator each with 4 horses were the most efficient. Labor, power, and equipment expenses averaged nearly 40 per cent of the gross income for the period for the farms studied.

Grain Losses When Harvesting with Different Harvesting Machines, N. I. Kalinin (Kalinine) (Sev. Kavkaz. Kraev. Selsk. Khoz, Opytn. Sta Bull. 295 (1929), pp. [24], figs. 10; Eng. abs., p. [24]).—The results of a series of experiments conducted in 1926 and 1927 at the North Caucasian Regional Agricultural Experiment Station in Russia to determine grain losses occurring during harvesting with the sickle, scythe, Russian harvester, binder and combine are reported. Winter and spring wheat, barley, and oats were harvested during these experiments. The heaviest loss occurred when harvesting with the scythe and the Russian harvester. The smallest loss occurred when harvesting with a sickle, and in many cases when harvesting with a binder.

Farm Equipment in Illinois, J. L. Schram (Chicago: Ill. Chamber of Commerce, 1928, pp. [7].—Data gathered by the University of Illinois and the Illinois Cooperative Crop Reporting Service on farm equipment in the State are summarized and analyzed for the year 1928. The results are based upon the farm equipment situation on about 6,250 farms.

Construction of a Sled-Type Cornstalk Shaver, F. Irons (U. S. Department of Agriculture, Miscellaneous Publication 69 (1930), pp. 10 figs. 22).—This shaver, which was developed by the division of agricultural engineering of the Bureau of Public Roads, is described and diagrammatically illustrated. The chief advantages of this stalk shaver are its simple construction, light weight, light draft, low cost and the possibility of placing two of the shavers abreast for cutting four rows of stalks at one time. It is especially adapted for use in connection with the European corn borer control.

Report Upon the Use of Agricultural Machinery and the Organization of Agricultural Labour in Australia, New Zealand, and Canada, A. Amos and J. Garton, ([Great Britain] Ministry of Agriculture and Fisheries Miscellaneous Publication 67 (1929), pp. 43, pls. 2).—This report summarizes the results of observations on the use of labor-saving machinery and methods in farming operations in Australia, New Zealand, Canada, and the United States, and discusses the possibility of their similar use in England.

Combine Harvester Investigation E. A. Silver, G. W. McCuen and N. W. Wilson (Ohio Station (Wooster) Bulletin 446 (1930), pp. 174-176).—The results of tests of combines for harvesting wheat, oats and barley are briefly summarized.

They indicated that the two greatest sources of waste came from the loss back of the cutter bar and the loss from threshing due to poor mechanical adjustments. The total machine loss ran from 0.4 to 10 per cent. The smaller per cent of loss was in a field of good standing wheat, and the largest was in a very weedy field of barley. However, this correlation did not always exist, as 9 and 7 per cent losses were found in two fields in which the crop was in excellent condition and free from weeds or other foreign material. The yields in these fields were 14 and 15 bushels per acre, respectively. The two combines that harvested these fields were found to be badly out of adjustment, especially as to slow cylinder speed. When the cylinder speed was raised from 820 to 1,010 rpm, the machine loss was reduced from 7.49 to 0.75 per cent.

The moisture content of the grain before and after combining showed a decided increase in the threshed grain except where the windrower and pick-up devices were used. The increase in moisture content of the threshed grain varied from 0.2 to 7.5 per cent, the amount of increase depending largely upon the amount of green material in the crop. Tests showed, however, that with all green material removed there is still a marked increase of moisture in the threshed grain.

In the test of the windrow-pick-up method, a 16-foot windrower was used with a 12-foot combine. These size units do not make a good combination because the tendency is for the operator of the combine ot move the machine too fast to handle a 16-foot windrow efficiently. However, with the ground travel of the combine reduced to a point where the machine was never overloaded, excellent results were obtained. Although the windrow suffered heavy rains before combining, the grain loss was negligible as compared with some of the tests on straight combining. The cutter bar losses were next to the smallest of any tests made, and there was no increase in moisture content of the threshed grain over that in the windrow before combining.

Factors Affecting the Drillability of Fertilizers A. L. Mehring (Industrial and Engineering Chemisty (Washington, D. C.), 21 (1929), No. 12, pp. 1219-1223, fig. 1).—Tests by the division of agricultural engineering of the Bureau of Public Roads and the Bureau of Chemistry and Soils, U.S.D.A., of the materials and mixtures representative of the fertilizers now in use in several standard fertilizer distributors are reported.

The results showed that the drillability of the fertilizers varied greatly with changes in relative humidity and only slightly with differences in temperature. All of them could be drilled satisfactorily at any humidity below 50 per cent, but none when exposed for a few days to a humidity above its hygroscopic point. Materials containing a considerable proportion of particles fine enough to pass a 200-mesh screen were unduly dusty when dry and undrillable when slightly damp, while those consisting of particles between 5 and 80 mesh were easily drilled when slightly damp and could be distributed in every case in atmospheres below their hygroscopic points.

The drillability of a fertilizer was found to vary inversely with its kinetic angle of repose. Mixed fertilizers composed of particles of different size, shape and specific gravity were found to segregate more or less during distribution, causing in some cases marked changes in the ratio of fertilizer delivered from time to time. The nearest approach to perfect distribution was obtained with a fertilizer composed of from 20 to 30-mesh rounded particles and having an angle of repose of 40 degrees.

Detonation Characteristics of Some of the Fuels Suggested as Standards of Antiknock Quality, J. M. Campbell, W. G. Lovell, and T. A. Boyd (S. A. E. (Society of Automotive Engineers) Journal (New York) 26 (1930), No. 2, pp. 163-168, figs. 5).—It is the purpose of this paper to present quantitative data on the detonation characteristics of certain engine fuels. The data are presented in terms of compression ratio for incipient knock over the entire range of composition from 0 to 100 per cent concentration as determined in admixture with normal heptane.

Normal heptane seems to be the only one of the several fuels included in the survey that has sufficient tendency to knock to make it suitable for the lower limit of a scale of antiknock quality consisting of two pure fuels mixed in various proportions, one of low and one of high antiknock quality. Of the fuels from which a selection might be made for the upper limit of such a scale, cyclohexane, iso-octane, benzene, toluene, and alcohol appear to have certain advantages and disadvantages, some of which are discussed.

Motor Vehicles and Tractors, P. M. Heldt, (Nyack, N. Y: Author, 1929, pp. VIII + 678, figs. 461).—This is both a textbook for students and a handbook for engineers. It is especially adapted for research engineers, since it has been the aim wherever possible to trace the relations of the mechanisms analyzed back to the fundamental principles involved. A special feature is a chapter dealing with some of the problems encountered in the design of tractors. Other chapters included are types of vehicle and their general arrangement; friction clutches; some principles of toothed gearing; change-speed gears; propeller shafts and universal joints; the differential gear; bevel-gear-driven rear axles; the worm drive; double reduction axles; front-drive, four-wheel-drive, and six-wheeled vehicles, brakes; front axles; the steering gear; control; frames and their brackets; chassis springs; independent suspensions; road wheels; chassis lubrication; gas-electric drives; the chain drive; fits and tolerances; and methods of rust protection.

The Influence of Plowing with a Milling Cutter, a Tiller, and a Plow on the Spread of Weeds, I. Shakhnov (Shahnov) (Sev. Kavkaz. Kraev. Selsk. Khoz. Opytn. Sta. Buil. 297 (1929), pp. 26, figs. 4; Eng. abs. pp. 25, 26).—Tests of a 35-horsepower milling cutter, a tiller plow with vertical crushers, and a tractor plow are reported. It was found that the milling cutter rendered the whole upper soil friable without turning it up sufficiently, thereby creating favorable conditions for the development of annual weeds. It destroyed and severely injured the roots of perennial weeds. The tiller provided the most favorable conditions for the development of all kinds of vegetation, including both crops and weeds. The total amount of weeds following the use of the tiller was about 17 per cent greater than after a milling cutter, and about 33 per cent greater than after a plow.

[Agricultural Engineering Investigations at the California Station] (California Station (Berkeley) Report 1929, pp. 48-51).—Studies by H. L. Belton and J. E. Dougherty on the relation of temperature to poultry house design indicated that while roof insulation has some value in controlling temperature, controlled ventilation is more effective within feasible limits in regulating house temperatures. Effectively installed insulation and controlled ventilation appear to be factors which should be used in combination. A droppings board constructed away from the rear wall permits better air circulation with resulting lower temperatures during a breeze but has little value on still evenings. Fan agitation of the air and roof sprinkling during hot weather apear to have little value. Electric heating, thermostatically controlled, for reducing dampness during winter weather showed some promise.

Laboratory tests by A. H. Hoffman of about 50 late model air cleaners for automotive engines showed efficiencies ranging from 100 per cent to less than zero. That is to say, some of the cleaners instead of protecting from dust, because of their placing, gather in and pass on to the carburetor more dust than would normally enter the properly placed open carburetor inlet. The restriction or vacuum effect is very low for many of the latest cleaners, producing no appreciable effect on carburetor action under normal conditions. Some cleaners tested increase rather rapidly in restriction under severe dust conditions. The most satisfactory cleaners are oily filter types. Road tests of vacuum effect of 18 cleaners showed that none when new would normally affect carburetor action seriously at speeds under 35 to 40 miles per hour. From 40 to 60 miles per hour restriction effects increase very rapidly. Tests made of dusts used by various air cleaner manufacturers to test the efficiency of their product showed large differences in floating and settling properties.

Gaseous Explosions.—VII, Effect of Tetraethyl Lead on Rate of Rise of Pressure, M. S. Carr and G. G. Brown (Industrial and Engineering Chemistry (Washington, D. C.), 21 (1929), No. 11, pp. 1071-1078, figs. 12).—In experiments conducted at the University of Michigan explosive mixtures of different types of hydrocarbons were prepared containing varying amounts of tetraethyl lead. The rate of rise of pressure following ignition was determined from pressure-time curves.

The effect of tetraethyl lead was found to be essentially independent of the chemical structure of the fuel, but governed by the type or rate of combustion of the explosive mixture. As the rate of reaction increases, the retarding action of tetraethyl lead disappears and is replaced by an accelerating action on the combustion. A similar effect was observed upon adding increasing amounts of tetraethyl lead to the mixture. Small amounts of tetraethyl lead tend to retard slow combustion, but larger concentrations of tetraethyl lead showed no retarding action and in many cases a positive accelerating effect.

These actions may be explained on the assumption that the decomposition products of tetraethyl lead are the active agents, and by considering the relative rates of decomposition of tetraethyl lead and of reaction of the explosive mixture.

Influence of Aluminum on Mortar Strength, H. W. Leavitt, J. W. Gowen and L. C. Jenness (National Academy of Science (Washington, D. C.) Proceedings, 15 (1929), No. 9, pp. 740-742, figs. 2).—Studies conducted at the Maine Technology Experiment Station are reported. The results indicate that aluminum in native sands affects 7-day and 28-day tensile strength in such a manner that the larger its amount the greater is the tensile strength. Aluminum does not materially affect the strength of the test cylinders in compression.

Winter Windows Need Weatherstripping J. Worth (Building Age, (New York), 51 (1929), No. 11, pp. 62, 63, figs. 3).—A brief summary of evidence in favor of weatherstripping of residence windows is given, together with practical information on the practice.

Units of Measurement and the Application of Irrigation Water, C. C. Wright (Washington College Station (Pullman) Popular Bulletin 145 (1929), pp. 21, figs. 7).—This bulletin, prepared in cooperation with the U.S.D.A. Bureau of Plant Industry, gives practical information on irrigation water measurement, delivery and application; making corrugations and distributing water; and the efficiency and economy of irrigation.

The Control of Gullies, R. E. Uhland and J. C. Wooley (Missouri Station (Columbia) Bulletin 271 (1929), pp. 24, figs. 22).—Practical information is given on the causes of gullying in soils and on control measures.

The plowing-in and seeding of gullies is applicable to those of both large and small size, provided the drainage areas are not too large. Straw furnishes a cheap and effective means for stopping the small washes which often occur in wheat fields, corn fields, and even in pastures and meadows, especially on moderate slopes where the drainage area is small. One of the most effective yet inexpensive ways of checking small washes in wheat fields, meadows or pastures is the use of bluegrass sod placed in old burlap fertilizer or feed bags.

It has been found advisable to use a crop rotation which includes a sod crop and which calls for a limited amount of cultivation, and to keep the soil covered with a sod crop, preferably a legume, as much of the time as possible.

Organic matter should be incorporated in the soil to increase the water-holding capacity.

Woven wire dams should be used in broad shallow gullies, although concrete triangular-notch dams can be used where a permanent structure is desired.

[Agricultural Engineering Investigations at the Pennsylvania Station], H. B. Josephson and R. U. Blasingame (Pennsylvania Station (State College) Bulletin 243 (1929), pp. 21, 22, figs. 2).—The progress of studies of power and labor, of electrical refrigeration requirements for Pennsylvania dairy farms, and of small portable electric motor requirements for Pennsylvaia agriculture is briefly recorded.

Economical Thickness of Heat Insulation, R. H. Heilman (Heating, Piping and Air Conditioning (Chicago) 1 (1929), No. 7, pp. 544-551, figs. 4).—Graphical and mathematical data are presented for the use of engineers in the design of heat insulation.

Substitutes for Wooden Breakpins A. H. Hoffman and E. G. McKibben (California Station (Berkeley) Bulletin 482 (1929), pp. 23, figs. 17).—Comparative tests of wooden and metal breakpins for the hitches of tractor-drawn implements indicated that the oak pins usually supplied with tractor plows and other heavy tillage implements vary greatly in breaking strength. Often the strongest in a lot of a dozen oak pins, identical in size and make, will carry twice the load that will break the weakest. In one lot in the tests the ratio was 3.8. On the other hand, soft iron or steel rivets are much more uniform in strength, the greatest difference observed between the strongest and the weakest of a size being only about 33 per cent. Steel wire nails are slightly less uniform than rivets. The metal substitutes for breakpins are not only more uniform but less expensive, and much less bulky.

The results of comparative tests of three spring overload release hitches were previously noted from another source.

Costs and Uses for Electricity on South Dakota Farms (South Dakota Station (Brookings) Bulletin 239 (1929), pp. 28, figs. 13).—This bulletin contains cost figures and other records of electricity used for farm purposes, most of which were taken from the farm homes and barns of patrons of the farm electric test line at Renner, S. D. Other results were obtained from actual investigations conducted at the station. The farms were practically all dairy or livestock farms.

The results suggest that a farm which is planned and operated in such a way as to use a considerable amount of electricity is the one that will make electricity pay best.

Another fact emphasized is the importance and advantage of having a farm line built primarily for farm service. The one large transformer, stepping down the voltage for a group of 17 farms, helps in distributing the cost.

Studies on Baritan River Pollution, 1927-28, W. Rudolfs et al. (New Jersey Stations (New Brunswick) Bulletin 489 (1929), pp. 72. figs. 28).—The results of a chemical and biological study of the Raritan River and its tributaries made during the different seasons of one year are reported. These show that the whole lower river and all its tributaries are polluted. The greatest pollution occurs in the Raritan River below the town of New Brunswick, because of the accumulative effect of the discharge of raw sewage and trade wastes along the banks of the river and its tributaries.

Bacteriological results show that a positive potential danger exists to public health in the whole lower river basin.

Chemical results show that oxygen consumption in the river is greater than the oxygen supply; that considerable amounts of acids, alkalies, dyes, poisons, and inert substances are discharged into the river and its tributaries; and that the raw sewage from about 150,000 people is augmented by a pollution equivalent of about 85,000 people from industries. The domestic and trade wastes pollution is injurious to fish life, especially during the summer months.

Clearing Land of Brush and Stumps, G. R. Boyd (U. S. Department of Agriculture, Farmers' Bulletin 1526 rev. (1929), pp. II + 34, figs. 19).—This bulletin supersedes Farmers' Bulletin 974. It describes the methods of brush and stump removal followed in different localities and points out the conditions under which their use is warranted.

An Economic Study of Farm Electrification in New York, With a Discussion of Rural Electrification in the Provinces of Quebec and Ontario, Canada, R. F. Bucknam (New York Cornell Station (Ithaca) Bulletin 496 (1929), pp. 65, fig. 1).—This bulletin reports data on the uses, costs, and possibilities of electricity on New York farms. Data are also included on rural electrification in the Provinces of Quebec and Ontario, Canada, and a comparison is given of the net cost of electricity in Ontario Province and in New York State. Copies of questionnaires used are appended.

The Application of Refrigeration to Dairying in the United States of America, J. T. Bowen (American Institute of Refrigeration Proceedings, 17 (1928), pp. 196-231, figs. 23).—In a contribution from the division of agricultural engineering of the U.S.D.A. Bureau of Public Roads an extended summary account is given of findings relating to dairy refrigeration.

Electropure Process Reduces Bacteria in Milk, E. D. Devereux (Michigan Station (East Lansing) Quarterly Bulletin, 12 (1929), No. 1, pp. 20-22.—This process for reducing bacteria in milk consists of passing the milk through a preheater where it is warmed to about 120 degrees (Fahrenheit). The milk then is pumped to the Electropure machine where it passes through a vertical chamber 3.5 by 4 by 24 inches. The 4-inch walls are made up of carbon electrodes and the 3.5-inch walls of insulating material. As the milk passes through it is subjected to an alternating electric current of 220 volts. The resistance offered by the various electrolytes in solution in the milk immediately causes the liberation of enough heat to reduce by approximately 99 per cent the bacterial plate count of the milk. This process does not alter the taste or creaming ability of the milk.

In experimental work a temperature of 160 degrees has been found very efficient, and this temperature has been reached when the milk has traveled about two-thirds of the distance, being exposed for only 15 to 20 seconds to the temperature.

Milk inoculated with spore-forming organisms, including the anthrax bacillus, has been passed through the machine with a reduction in different trials of from 71.5 to 99.9 per cent of the spores. In comparison, tubes containing the same milk treated in a manner similar to steam sterilization showed a reduction in the spore organisms of from 0 to 13 per cent.

Sterilization of Milk Bottles in Soaker Type Washers, L. Shere and G. L. Hoeft (American Journal of Public Health, (New York) 19 (1929), No. 7, pp. 747-750).—Bacterial counts of 1,885 bottles from 9 different washing machines were made at intervals over a period of 15 months in this study. Sample bottles were collected from the machines after soaking in caustic solution, after the brushing or pressure rinses, after plain rinsing, and after sterilizing. Plating of samples was done within 5 minutes after the bottles were removed from the machines.

In one case all of the bottles that emerged from the soaker solution had counts under 500, while on other runs counts were 99, 96, 94, 82, and 76 per cent satisfactory. Of the bottles delivered by the machine after soaking, rinsing and sterilizing, in six of nine cases all had counts under 500, two were 99 per cent, and one 97 per cent satisfactory for compliance with bacterial count standards. All bottles which had been contaminated heavily with a suspension of Bacillus coli gave negative results. The study indicates the value of sterilizing milk bottles by exposure to temperatures of 165 degrees (Fahrenheit) for 5 minutes or to 195 degrees momentarily, or of rinsing in a solution of chlorine disinfectant having a concentration of 35 parts of available chlorine per million.

Strength of Materials, A. P. Poorman (New York and London: McGraw-Hill Book Co., 1929, 2. ed., pp. XIII + 343, figs. 214).—This is the second revised edition of this book, which is based on work done at Purdue University.

Recent Developments in Corrosion-Resistant and Heat-Resistant Steels, J. A. Mathews (Industrial and Engineering Chemistry, (Washington, D. C.), 21 (1929) No. 12, pp. 1158-1164, figs. 4).—Information on various commercial products is presented.

AGRICULTURAL ENGINEERING

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RAYMOND OLNEY, Editor

R. A. Palmer, Assistant Editor

New Viewpoints in Farm Management

SOME points brought out in a recent article on the management of small manufacturing plants[1] are worth thinking about as considerations in farm management.

Small manufacting organizations have had little sympathy, sentiment or legislative effort wasted on them. They exist for the sole purpose of supplying commodities to fulfill human needs. Each such organization prospers in proportion as it enjoys advantages in the fulfilling of certain human needs which render it unique. It may be unique in products, process of manufacture, source of raw materials, source of power, manner of selling, sales territory, trade, manner of shipping, collection methods, advertising, or good will. Its degree of uniquity is measured by its market position—its dollars and cents advantage over other ways of fulfilling the same need.

How many farms enjoy any degree of uniquity over all other farms? Farms originally were cleared and operated to meet the needs of the farm family settling thereon. In the gradual transformation of agriculture from this self-sufficient basis to the present commercial basis, how many farmers have caught the important vision of producing to meet the needs of other people?

Any industrial organization which employs less than 250 men is considered small. Measured by this standard even our larger farms are small. Upon what can such small organizations pin their hopes for success?

Uniquity we have already mentioned. The smaller the production unit, the more important this is. It is the only means of getting around the competition of larger organizations which enjoy the advantage of mass production and of the favors which money can buy. It is achieved by keeping close to the ultimate consumer and sensitive to his wants; by specializing in product, method of manufacture or marketing to meet certain of those wants; and by utilizing special machinery and equipment which is particularly adapted to meet the special production requirements.

Another factor of particular importance to the success of the small production unit is versatility on the part of its management. The small organization has to cope with almost as wide a variety of problems as are handled in a large organization, but it has too few executives to permit an extensive specialization or functionalization of their work. Versatility may, however, prove as serious as the lack of it. A versatile man is apt to get into too many businesses, or to try to spread his business over too many lines. This makes management one of the most difficult problems of the small business.

Suggestions for making a small industry successful have been boiled down to three rules[2] which agricultural engineers and farm managers may profitably remember as applying equally well to farms. They are:

1. Make the best product
2. Watch costs; fight them with daring
3. Watch shifting markets; particularly with respect to the salability of the product.

[1] Field, Crosby, "Management of the Small Manufacturing Plant: Its Characteristics and Advantages," Mechanical Engineering, Vol. 52, No. 10 (October 1930).

Overall Efficiency

OUR attention is again focused upon the importance of each agricultural engineer working with a view to increasing the overall efficiency of farms as economic production units, rather than concentrating too closely upon increasing the efficiency of one machine or operation.

George W. Kable's article in this issue expresses the point effectively from the standpoint of his particular field in the words " . . . . . the ultimate good of farm electrification is not motors and meters but good sound engineering analysis and management proven by the annual net income. This problem, in my opinion, should occupy first place in future farm electrification studies.

". . . . . While the adaptation of electricity to present farming operations is important, there is a need and an opportunity for forgetting some of our ingrained practices and sentiments about farming and the facing of the problems of agriculture with this daily solver of mysteries, unhampered by custom and prejudice."

What Mr. Kable says here of rural electrification applies also to power and machinery, structures and land reclamation. We need to think of these as means to the end of enabling specific agricultural enterprises to show economic results which justify their existence.

Justification and Progress

ALL objections to the extensive application of engineering to agriculture divide into two groups and can conveniently be filed in as many wastebaskets labelled, for handy reference, "Objections on Economic Grounds" and "Objections on Sociologic Grounds."

Power farmers are daily producing an overwhelming body of concrete evidence disproving the economic objections. Even the over-production bogy falls before low production costs and new non-stomach uses for farm products.

We can also easily satisfy ourselves that the objections on sociologic grounds are specious. We know that every step in economic progress down through the ages has met at first with social opposition, and has later been followed by a corresponding step in social progress. Readjustments have been necessary and regressions have occurred, but due to economic progress more people are today finding the world a better place in which to live than ever before. In fact, the power of agriculture as an influence for social progress depends on its economic rating and progressiveness.

But it is not enough that we satisfy ourselves of the social as well as the economic justification of our profession. To insure the support and cooperation we need from other sources to expedite our work we must make its social value as evident as its economic value. This means giving more attention to the study and measurement of human values, and the influence upon them of machines and material welfare.

[2] Ranck, Z. W., "I'd Rather Run a Small Business," Factory and Industrial Management, Vol. 78 (1929), pp. 1063-5.

A. S. A. E. and Related Activities

Program

Meeting of the

Power and Machinery Division

American Society of Agricultural Engineers

Hotel Stevens, Chicago, Illinois, December 1, 2 and 3, 1930

FARM MANAGEMENT PROGRAM

D. Howard Doane presiding

Forenoon Session — 9:30 a.m. — Monday, December 1

PAPER: "Organization of a Modern Diversified Farm"—A. B. Van Schoik, general manager, The Farms Operating Corp. (Michigan)

Discussion led by Geo. G. Seaman, Illinois large-scale farmer

PAPER: "Operating a 50,000-Acre Cotton Plantation"—Oscar Johnson, president, Delta Pine & Land Company (Mississippi)

Afternoon Session — 2:00 p.m

PAPER: "The Industrialization of Dairy Production"—Howard T. Greene, treasurer, Brook Hill Farm (Wisconsin)

Discussion led by Basil Howell, agricultural engineer, Brook Hill Farm

PAPER: "Modern Dairy Management and Its Effect on Cost of Production"—Dr. R. R. Graves, chief, division of feeding, breeding and management, Bureau of Dairy Industry, U. S. Department of Agriculture

Evening Session — 7:00 p.m.

Dinner (followed by short program)

ADDRESS: "Relation of Professional Farm Manager to the Present Agricultural Situation"—Dr. W. J. Spillman, Bureau of Agricultural Economics, U. S. Department of Agriculture

ADDRESS: "The Farm Manager and His Responsibility to the Profession"—Frank W. Reinoehl, chief farm manager, Colonization Finance Corp. of Canada, Ltd.

O. B. Zimmerman presiding

Forenoon Session — 9:30 a.m. — Tuesday, December 2

PAPER: "Land Reclamation Problems as Affecting Farm Machinery Application"—John Swenehart, agricultural engineer, Atlas Powder Co.

SYMPOSIUM: "Engineering Developments in Machinery for Terracing"—Led by C. E. Ramser, senior drainage engineer, U. S. Department of Agriculture

Discussions by

D. S. Weaver, agricultural engineer, North Carolina State College

H. P. Smith, agricultural engineer, Texas Agricultural Experiment Station

J. C. Wooley, agricultural engineer, University of Missouri

Afternoon Session — 2:00 p.m.

TALK: "Observations of a European Trip of Interest to Agricultural Engineers"—G. D. Jones, agricultural engineer, Cleveland Tractor Co.

PAPER: "Today's Job for the Agricultural Engineer"—by L. J. Fletcher, agricultural engineer, Caterpillar Tractor Co.

REPORT: "A Review of Power Take-Off Standardization Work"—W. L. Zink, chief engineer, General Implement Co.

PAPER: "Progress of Foreign Standardization of Agricultural Machinery"—John Gaillard, mechanical engineer, American Standards Association

O. B. Zimmerman presiding

Forenoon Session — 9:30 a.m. — Wednesday, December 3

PAPER: "Status of the Development of Machinery for Beet Production"—E. M. Mervine, agricultural engineer, U. S. Department of Agriculture

Discussion led by C. T. Lund, American Beet Sugar Co.

PAPER: "Chain Applications in Agricultural Equipment"—C. R. Weiss, chief engineer, Link-Belt Company

PAPER: "Cotton Harvesting Development Up-to-Date"—H. P. Smith, agricultural engineer, Texas Agricultural Experiment Station

Afternoon Session — 2:00 p.m.

PAPER: "Universal Joint Design for Farm Machinery"—H. D. MacDonald, engineering department, International Harvester Co.

SYMPOSIUM: Progress in General-Purpose Tractor Development"—

G. D. Jones, agricultural engineer, Cleveland Tractor Co.

R. U. Blasingame, agricultural engineer, Pennsylvania State College

General Discussion

SYMPOSIUM: "Status of the Development of Corn Harvesting Equipment"—

A. L. Young, agricultural engineer, University of Illinois

C. A. Logan, agricultural engineer, Kansas State Agricultural College

Program

Meeting of the

Structures Division

American Society of Agricultural Engineers

Hotel Stevens, Chicago, Illinois, December 2 and 3, 1930

F. C. Fenton presiding

Forenoon Session — 9:30 a.m. — Tuesday, December 2

REPORT: "Status of Dairy Barn Standards (Final Report on A.S.A.E. Dairy Barn Questionnaire)"—W. G. Ward, agricultural engineer, Kansas State Agricultural College

General discussion

REPORT: "U.S.D.A. Farm Structures Research Survey (Final Report)"—Henry Giese, agricultural engineer, Iowa State college

General discussion of plans for future research in the farm structures field

REPORT: "Results of Tests of Motor-Driven Dairy Barn Ventilation System"—A. W. Clyde, agricultural engineer, Iowa State College

Afternoon Session — 2:00 p.m.

SYMPOSIUM: "Problems in the Efficient and Economical Farm Storage of Grain, Corn and Rice"—

1. "Economics of Storing Grain on the Farm"—E. J. Bell, Jr., grain storage economist, Federal Farm Board
2. "Effect of Storage Upon the Quality of Grain"—E. G. Boerner, in charge of grain investigations, Bureau of Agricultural Economics, U. S. Department of Agriculture
3. "Proper Storage Facilities for Safe Keeping of Wheat"—R. H. Black, in charge of grain cleaning investigations, U. S. Department of Agriculture
4. "Proper Storage Facilities for Safe Keeping of Corn"—M. A. R. Kelley, agricultural engineer, U. S. Department of Agriculture
5. "Proper Storage Facilities for Safe Keeping of Rice"—W. D. Smith, rice investigations, Bureau of Agricultural Economics, U. S. Department of Agriculture, and J. D. Long, junior agricultural engineer, University of California
6. "Results of Recent Experiments in Artificial Drying of Grain"— Led by W. M. Hurst, agricultural engineer, U. S. Department of Agriculture

F. C. Fenton presiding

Forenoon Session — 9:30 a.m. — Wednesday, December 3

REPORT: "Present Practice in Farm Building Investment on Missouri Farms"—J. C. Wooley, agricultural engineer, University of Missouri

PAPER: "Modernizing the Farm Home"—R. E. Gray, American Farm Bureau Federation

PAPER: "Problems in Farm House Design"—H. E. Wichers, Kansas State Agricultural College

PAPER: "Research in Farm House Design"—Wm. Draper Brinckloe, architect

Afternoon Session — 2:00 p.m.

W. C. Harrington presiding

PAPER: "Plans for the Study of the Economics of Farm Structures"—J. L. Strahan, agricultural engineer, Louden Machinery Company

REPORT: "The Future of Research in Farm Structures"—Henry Giese, agricultural engineer, Iowa State College

BUSINESS SESSION

Dairy Engineers Show Growing Strength

UNUSUALLY close attention to the program, larger attendance and the presentation of carefully prepared papers at the second annual "Dairy Engineer's Day" technical meeting, held in Cleveland, October 23, in connection with the National Dairy Industries Exposition, reflected a growing group consciousness on the part of dairy engineers.

It was estimated that some 250 dairy engineers and plant men stole as much time as possible from their work at their exposition booths and from the two other conventions, numerous committee meetings and other attractions, to hear the dairy engineering papers which were of particular interest to them. Many others who would have liked to attend were too tied down with other duties to make it possible.

The exposition as a whole was the largest and most successful of its kind ever held. It showed clearly that dairying and its related industries are still enjoying rapid growth and technical progress. The wealth and variety of equipment and products exhibited did credit to the genius which has, in the space of some thirty years, applied engineering successfully to dairy production, and also through the application of engineering, virtually created the dairy manufacturing industries.

H. S. Fielder of the Cherry-Burrell Corporation, as chairman for the morning session, called the meeting to order. He presented H. H. Miller, president of the Dairy and Ice Cream Machinery and Supplies Association which sponsors the exposition. Mr. Miller gave the address of welcome, in which he indicated that men in non-engineering branches of dairy industries work are beginning to realize more and more the importance of engineering to the industries and to their personal interests as owners or employees.

A shift in the program placed "Heat Transfer in Dairy Equipment" as the first subject for consideration. As H. J. Macintire of the University of Illinois was unable to be present his paper was read by title, and R. L. Perry, University of California, presented a discussion of the subject. His contribution dealt principally with the fundamental laws of heat transfer as applied to surface coolers.

"Plant Equipment Supervision Program" was the next subject considered. H. F. Judkins of the General Ice Cream Company introduced the subject and Ward E. Guest of the Kraft-Phoenix Cheese Company led the discussion. Mr. Judkins emphasized performance standards and operating instructions, and Mr. Guest covered plant factors such as location, construction, transportation, water supply and sewage disposal, which materially influence equipment performance.

"The Field for Dairy Engineers" was handled by H. A. Sieck, of the Creamery Package Manufacturing Company. In his address, Mr. Sieck showed how engineering is essential in planning the plant and its equipment. It is the duty of the engineer, he stated, to guard against unprofitable plants by weighing all the facts as to probable volume of business, territory served, rate of growth and relation of investment to revenue; then planning and equipping the plant according to the needs of the situation. He believes the engineering type of mind is of value in selling as well as buying equipment and that this situation offers a large field for dairy engineers.

The subject of "College Instruction in Dairy Engineering" was presented in the form of a committee report by L. C. Thomsen of the University of Wisconsin. This report gave results of a survey of the need for and availability of training in dairy engineering in this country. It concluded that there is need for at least three colleges in the United States to give specialized work on this subject, and the survey also showed that there are openings for men of the right type and training in this field. It gave a suggested curriculum. The report was prepared by M. Mortensen, head of the dairy department, Iowa State College; J. H. Godfrey, Creamery Package Manufacturing Company; and Mr. Thomsen, who was chairman of this sub-committee of the A.S.A.E. Committee on Dairy Engineering. Mr. Godfrey discussed the report briefly, emphasizing the advantages of the proposed 5½-year course. At the suggestion of A. W. Farrall, chairman of the main committee, the audience voted an expression of approval of the report as presented.

A paper prepared by M. Van Antwerpen, chairman of the Standardization Committee of the International Association of Milk Dealers, was read. In it the progress of the work was covered and compliments paid the manufacturers for their cooperation. This closed the forenoon session.

The afternoon meeting opened with a group of three papers on dairy plant layout. C. E. Clement, Bureau of Dairy Industry, U.S.D.A., gave the results of a study as to man-hour requirements for various operations in plants of several types. The plant operator's standpoint was given in a paper by F. H. Kullman, Jr., chief engineer, Bowman Dairy Company, who covered fully the various factors involved, such as location, advertising value, provision for enlarging capacity and the necessity for providing for change of equipment without extensive building alterations. J. J. Mojonnier of Mojonnier Brothers Company discussed engineering factors in dairy plant layout, showing how old plants had been modernized.

Dr. H. A. Ruehe, head of the dairy department of the University of Illinois, presented the subject of "Research as Applied to Dairy Machinery," and clearly outlined proper methods of attacking a research problem. He also mentioned certain problems which were in need of solution at the present time. He stated that the ideal would be reached when all major processes were made continuous.

Harvey Feldmier, chief engineer of the Cherry-Burrell Corporation, was reminiscent in opening his talk on "Factors Involved in the Design of Dairy Machinery." He called attention to the fact that only 37 years ago, when he entered dairy engineering work, dairy equipment was small, cheap and unsanitary. Among factors which have helped to bring about changes in design he mentioned civil authorities, the growth of the industry, and the trade associations.

"Disposal of Creamery Wastes" was covered in two papers, one by Max Levine, professor of sanitary bacteriology, Iowa State College, and the other by A. Elliot Kimberly, consulting engineer, Columbus, Ohio. Both speakers stressed the differences between dairy plant and domestic sewage, which differences make it difficult to handle them. Mr. Levine showed that the high acidity of untreated creamery waste is a primary cause of trouble and reported experiments leading to what promises to be a successful solution. Aeration in a trickling filter of proper proportions is the angle on which they are now working with two full-sized experimental plants. Mr. Kimberly discussed the practical side of building disposal systems and explained the necessity for exact knowledge as to kind and quantity of wastes before planning a system.

F. L. Chappell, manager of the Sheffield By-Products Company, presented a paper on "Engineering Principles Involved in the Continuous Method of Casein Manufacture," in which he described a new continuous process developed by his company.

The last paper on the program was a discussion of "Low Temperature Freezing," involving the use of freez-

ing tunnels, and carbon dioxide apparatus. It was presented by Leon Buehler, Jr., of the engineering staff of Frick Ice Machine Company.

The A.S.A.E. Committee on Dairy Engineering, members of which are A. W. Farrall, chairman; R. L. Perry, H. S. Fielder, J. H. Godfrey, L. C. Thomsen, and J .T. Bowen, has already announced that it plans to sponsor a similar meeting next year. There is a possibility, however, that arrangements will be made to hold it separate from and at some time which will not conflict with the exposition, in order to enable all interested dairy engineers to attend.

Arrangements Complete for Second Reclamation Division Winter Meeting

CALIFORNIA, San Francisco, and the Whitcomb Hotel are ready; the program is completed; local arrangements have been taken care of; and only Tuesday morning, January 6, is awaited as the scheduled time for Frank Adams to bring down the gavel to open the second winter meeting of the Land Reclamation Division of the American Society of Agricultural Engineers.

The Pacific Coast Section of the Society invited the Division to meet on the Coast and as host has been responsible for all arrangements, including the building of the program. The West being the country of large reclamation projects, it is believed that holding the meeting there will enable the maximum number of those interested to attend.

As indicated Frank Adams, professor of irrigation investigations and practice, University of California, will preside at the opening session. B. B. Meek, director of the California state department of public works, will deliver the address of welcome. "Reclamation and Development in the Sacramento-San Joaquin Delta" is the title of a contribution to this session to be made by Geo. A. Atherton, general manager of California Delta Farms.

Following a luncheon the Reclamation Division and the Pacific Coast Section will each hold a short business meeting.

The Hon. Ray Lyman Wilbur, Secretary of the Interior, has shown a great deal of interest in the meeting and has promised to provide an authority to speak on "The Conservation of Public Domain." This address is scheduled for presentation at the opening of the first afternoon session. "Economic Problems of Western Reclamation," by John W. Haw, director of agricultural development for the Northern Pacific Railroad, is the other address to be presented at that session.

A banquet is to be held the evening of the first day. "Utilization of Water and Power from Boulder Canyon Project" has been selected as a timely topic of general interest for the principal banquet address. Dr. Elwood Mead, Commissioner of Reclamation, has agreed to deliver this address in person if at all possible. In the event that it is not possible for him to do so, he will provide a speaker competent to handle the subject. L. F. Livingston, Chairman of the Reclamation Division, will preside.

Three papers are billed for the morning session of the second day, Wednesday, January 7. E. I. Kotok, director of the California Forest Experimental Station, and Walter Mulford, professor of forestry, University of California, will collaborate in presenting the subject "Present Status of Facts and Opinions on the Relation of Forest Cover to Water Conservation." "Problems of Soil Erosion and How They are Being Met" is the title of the paper S. H. McCrory, chief of the division of agricultural engineering, U.S.D.A., has chosen to present if it is possible for him to attend. In the event of his absence, L. A. Jones, drainage engineer in his division, will probably be the one who will cover the subject. Agricultural engineers who are primarily interested in farm machinery wil especially want to hear the concluding paper of this session. "Influence of Reclamation on Design and Development of Farm Machinery" by B. D. Moses, vice-president of the American Society of Agricultural Engineers; associate professor of agricultural engineering, University of California.

At a luncheon meeting W. W. McLaughlin, associate chief of the division of agricultural engineering and chairman of the second day's sessions, will introduce Chas. F. Shaw, professor of soil technology, University of California. Prof. Shaw has recently studied soils and land reclamation problems in China and will tell of some of his experiences and findings.

Mae E. Schnurr, assistant to the Commissioner of Reclamation, will speak at the final session, the afternoon of the second day, on "Woman's Part in Reclamation." At the same session H. D. Ellis, president of the Federal Land Bank of Berkeley, will talk on "Financing Reclamation" and Walter D. Wagner, commissioner of reclamation financing for the western region of the American Farm Bureau Federation, will lead a general discussion of this subject which will bring the meeting to a close.

In presenting this program the Division is supporting and calling public attention to the principle it laid down in its meeting last year—lands should be made to net continuously the greatest possible benefits to the owner, operator and general public. It is believed that the program will help to clear up public misunderstanding of the economic significance of reclamation activities at the same time that it is enabling reclamation specialists to learn more about their field and to gain new inspiration for their work.

Division Appointments

PRESIDENT R. W. Trullinger has recently appointed O. B. Zimmerman of the International Harvester Company as chairman of the Power and Machinery Division of the American Society of Agricultural Engineers for the remainder of the Society year 1930-31, to succeed H. E. McCray who resigned owing to the fact that he has left the agricultural engineering field to engage in an air transportation project.

E. C. Easter, of the Alabama Power Company, has been appointed chairman of the Rural Electric Division for the remainder of the Society year, to succeed J. E. Waggoner who has, as previously announced, left the rural electrification field to join the Oliver Farm Equipment Company.

Dairy Engineers Hold Western Meeting

THE Pacific Slope Dairy Show is again the occasion for a meeting of dairy engineers sponsored by the Pacific Coast Section of the American Society of Agricultural Engineers. Thursday, November 13, is the day when the dairy engineers will gather at the Municipal Auditorium, Oakland, California, where the Dairy Show is being held.

It was a very similar meeting in connection with the same event several years ago which first brought a small group of dairy engineers together to study their technical problems as a body of professional men. This led to national meetings of dairy engineers held last year and this year in connection with the National Dairy Industries Exposition, and to subsequent meetings at each annual Pacific Slope Dairy Show.

Several papers on the Oakland program deal with the application of engineering at the production end of the industry. "Compressed Gas for Dairy Farm Use" is the

title of one of these papers which T. Rosebaugh of the Shell Company and R. L. Perry, University of California, collaborated in preparing. W. S. Gilpin of the Golden State Milk Products Company is author of a paper on "Walk-Through Milking Sheds and Dairy Farm Layout." C. R. Kranz of the Binks Company is scheduled to present the subject of "Cooling Towers for Dairy Farm Refrigeration."

A subject which is on the border line between the production and processing ends of the industry is "Milk Transportation from Farm to Plant," which will be covered by C. G. Anthony of the Pacific Freight Terminal Company.

Two papers deal with the fuel problems of dairy plants. They are "Natural Gas or Oil for Dairy Plant Boilers" by W. N. Thayer of the Coast Gas and Electric Company, and "Heat and Power Generation in Dairy Plants" by Hugh Asselstine, California Dairies, Inc.

"Flooded System Evaporators" is the title of a contribution by W. W. Sandholt of the York Ice Machinery Corporation.

Pasteurizers will be discussed from the standpoint of design by L. O. Ott of the Cherry-Burrell Corporation and from the user's viewpoint by D. H. Nelson, dairy industry division, University of California.

R. L. Perry who is in charge of dairy engineering research in the division of agricultural engineering, University of California, and a member of the American Society of Agricultural Engineers Committee on Dairy Engineering, was a moving spirit in arranging the meeting.

Personals of A.S.A.E. Members

R. D. Marsden, senior drainage engineer, Division of Agricultural Engineering, U.S.D.A., is joint author with R. P. Teele of U.S.D.A. Technical Bulletin No. 194 entitled "Economic Status of Drainage Districts in the South in 1926."

S. H. McCrory, chief of the division of agricultural engineering, Bureau of Public Roads, U. S. Department of Agriculture, has been selected as one of a group of scientists to contribute to a series of programs which will go on the air in the next several months over the National Broadcasting Company chain. "Science" is the general subject of the series, which will be broadcast on Wednesday evenings. The evening on which Mr. McCrory will talk has not yet been announced.

C. E. Ramser, senior drainage engineer, division of agricultural engineering, U.S.D.A., is author of U.S.D.A. Technical Bulletin No. 184, entitled "Erosion and Silting of Dredged Drainage Ditches."

C. O. Reed, professor of agricultural engineering, Ohio State University, and **R. B. Gray,** senior agricultural engineer, division of agricultural engineering, U.S.D.A., are joint authors with L. H. Worthley and D. J. Caffrey of U. S. Department of Agriculture Circular No. 132, entitled "Fighting the Corn Borer with Machinery in the Two-Generation Area."

New A.S.A.E. Members

Ralph H. Allee, graduate student, California State College of Agriculture, Sacramento, Calif.

Clarence O. Bennett, rural service representative, Niagara, Lockport & Ontario Power Co., Batavia, N. Y.

Almeron M. Frost, manager, agricultural sales, Pacific Gas & Electric Co., San Francisco, Calif.

David P. Livingston, advertising department, Meredith Publishing Co., Des Moines, Ia.

Ralph Piper, assistant engineer, Wisconsin Michigan Power Co., Appleton, Wis.

Transfer of Grade

James D. Swan, training course, J. I. Case Co., Syracuse, N. Y. (Student to Junior Member.)

Earl T. Swink, graduate student, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. (Student to Junior Member.)

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the October issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Howard H. Beningfield, technical representative, Cleveland Tractor Co., Cape Town, South Africa.

Everett B. Cushman, mechanical engineer, Food Machinery Corp., San Jose, Calif.

Ernest E. Einfeldt, chief engineer, French & Hecht, Davenport, Ia.

J. B. Fisher, chief engineer, Waukesha Motor Co., Waukesha, Wis.

Carroll F. Nelson, rural electrification, Niagara Hudson Power Co., Jamestown, N. Y.

Transfer of Grade

Carl G. Krieger, Jr., agricultural engineer, Ethyl Gasoline Corp., New York, N. Y. (Junior to Associate Member.)

Employment Bulletin

An employment service is conducted by the American Society of Agricultural Engineers for the special benefit of its members. Only Society members in good standing are privileged to insert notices in the "Men Available" section of this bulletin, and to apply for positions advertised in the "Positions Open" section. Non-members as well as members, seeking men to fill positions, for which members of the Society would be logical candidates, are privileged to insert notices in the "Positions Open" section and to be referred to persons listed in the "Men Available' section. Notices in both the "Men Available" and "Positions Open" sections will be inserted for one month only and will thereafter be discontinued, unless additional insertions are requested. Copy for notices must be received at the headquarters of the Society not later than the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. There is no charge for this service.

Men Available

FARM MANAGER, with 15 years' experience in large-scale power farming and livestock operations desires a position. Has had wide experience in development of both arid and irrigated lands with power machinery and equipment. Also some experience in land drainage. College degree and associate member of American Society of Agricultural Engineers. Salary and share in profits preferred. Would take some stock in a company organization. MA-185.

Positions Open

CIVIL SERVICE OPENINGS

The U. S. Civil Service Commission has announced open competitive examinations (unassembled) for the positions of senior agricultural engineer ($4,600 to $5,400), agricultural engineer ($3,800 to $4,600), associate agricultural engineer ($3,200 to $3,800). Openings indicated are for work in either farm structures, erosion control or both. Qualification standards for applicants are as usual, except that applicants for the examination for senior agricultural engineer must be qualified in farm structures; applicants for the examination for agricultural engineer must be qualified for erosion control work; and applicants for the examination for associate agricultural engineer may be qualified in either of these branches. Those who wish to apply should secure and execute from 2600, giving on it the number (283) and exact title of the examination desired. Applications must be on file with the Commission at Washington not later than December 3.